Journal

OF THE

ELISHA MITCHELL Scientific Society

VOL. 66, NO. 2 DECEMBER, 1950

Contents

PROCEEDINGS OF THE FORTY-SEVENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE 93

PROCEEDINGS OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY 121

HERPETOLOGICAL NOTES FROM EASTERN NORTH CAROLINA. *William B. Robertson* and *Edwin L. Tyson* 130

A NEW SPECIES OF DIAPTOMID COPEPOD FROM MANITOBA... *I. Gilbert Arnason* 148

SOME ESTERS OF THE ISOMERIC NITRO- AND AMINOBENZENESULFONIC ACIDS. *R. W. Bost* and *George F. Deebel* 157

A STUDY OF THE CONDITIONS INVOLVED IN THE PREPARATION OF 3,5-DIIODO-4-OXO-1-PYRIDINE-ACETIC ACID(DIODRAST) CONTAINING IODINE-131 *Arthur Roe, R. L. Hayes,* and *H. D. Bruner* 163

THE ODORS OF MONO- AND DIARYLALKANES. *Walter H. Hartung* and *Henry Dale Smith* 171

A STUDY OF THE TRANSLOCATION OF RADIOACTIVE PHOSPHORUS IN LOBLOLLY PINE (*Pinus Taeda* L.)..... *Donald E. Moreland* 175

SOME PHYSIOLOGICAL ASPECTS OF FERTILITY IN *Achlya tuberculata*. *A. W. Ziegler* and *Betty Linthicum* 182

STUDIES IN THE COMPOSITAE OF NORTH CAROLINA. III..... *R. K. Godfrey* 186

THE UMBELLIFERAE OF NORTH CAROLINA AND THEIR DISTRIBUTION IN THE SOUTHEAST..... *Charles Leland Rodgers* 195

Published for the Society by

THE UNIVERSITY OF NORTH CAROLINA PRESS *at* CHAPEL HILL

The Elisha Mitchell Scientific Society

Founded in 1883 through the efforts of Francis Preston Venable

D. P. COSTELLO, President

P. E. SHEARIN, Vice-President

E. T. BROWNE
Corresponding Secretary

A. E. RADFORD
Recording Secretary-Treasurer

EDITORS OF THE JOURNAL:

J. N. COUCH, Chairman

W. C. GEORGE

G. R. MACCARTHY

E. T. BROWNE, *Ex officio*

ALMA HOLLAND BEERS, Executive Editor

JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY—Semi-annual. Price $3.00 per year; single numbers, $1.50. Direct all correspondence to the Corresponding Secretary, at the University of North Carolina, Chapel Hill, N. C.

In addition to original papers on scientific subjects, this Journal publishes the Proceedings of the Elisha Mitchell Scientific Society, and the Proceedings of the North Carolina Academy of Science, including some abstracts of papers on scientific subjects published elsewhere.

PUBLISHED FOR THE SOCIETY
BY THE
UNIVERSITY OF NORTH CAROLINA PRESS

Made in the United States of America

JOURNAL

OF THE

Elisha Mitchell Scientific Society

Volume 66 December 1950 No. 2

PROCEEDINGS OF THE FORTY-SEVENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE

The forty-seventh annual meeting of the North Carolina Academy of Science was held at Catawba College, Salisbury, N. C., on May 5 and 6, 1950.

The Academy convened in a general session at 10:30 a.m. on the first day with President C. F. Korstian presiding. Papers were read at both morning and afternoon sessions. These were followed by the business meeting.

The minutes of the 1949 meeting were approved as published in the Journal of the Elisha Mitchell Scientific Society **65:** 167–208. The reports of the various committees were then presented as follows:

Report of the Executive Committee

The Executive Committee met at the home of Dr. M. L. Braun of Catawba College on May 4, 1950, and at luncheon on May 5, 1950. At these meetings the following matters were transacted:

1. The committee authorized the Treasurer to pay all outstanding bills for operating expenses and to submit his financial report as of July 1, 1950, to the auditing committee.
2. The committee voted to become an affiliate of the Southern Association of Science and Industry, Inc.
3. The following were elected to membership in the Academy:

Adams, Elizabeth, Chemistry, Woman's College, U. N. C.
Beamer, Parker Reynolds, Microbiology and Immunology, Bowman Gray School of Medicine
Berkeley, Edmund, Botany, University of North Carolina
Booth, John Sidney, Chemist, Liggett and Myers Tobacco Company
Brown, Edward B., Botany, Duke University
Bullard, Adelaide Petree, Science, Lumberton High School
Caffey, Michael David, Jr., Psychology, N. C. State College
Carpenter, Walter Jackson, Mathematics, Western Carolina Teachers College
Chipman, Walter Albert, Biologist, U. S. Fishery Laboratory, Beaufort
Clodfelter, Henrietta, Biology, Catawba College
Cornell, James H., Fish Division, N. C. Wildlife Resources Commission
Crowder, Marietta, Biochemistry, Bowman Gray School of Medicine
Davis, David Boyd, Catawba College
Dobrovsky, Todor Manoloff, Entomology, N. C. State College

Donat, Winfield, Education Division, N. C. Wildlife Resources Commission
Douglas, George A., Sociology, Davidson College
Finkner, Morris Dale, Agronomy, N. C. State College
Fogelberg, Sidney Otto, Botany, Carolina Biological Supply Company
Freeman, Claire E., Science, Needham Broughton High School, Raleigh
Funderburg, John B., Jr., Wilmington Junior College
Geary, John Maurice, Entomology, N. C. State College
Goedicke, Thomas Robert, Geology, University of North Carolina
Graham, Fred William, Jr., Botany, Duke University
Green, Harold D., Physiology and Pharmacology, Bowman Gray School of Medicine
Greulach, Victor A., Botany, University of North Carolina
Haynes, Hubert Calvin, Psychology, East Carolina Teachers College
Headinger, Henry A., Carolina Rubber Company, Salisbury
Hornaday, John Albert, Psychology, Woman's College, U. N. C.
Hoyle, Hughes Bayne, Jr., Mathematics and Physics, Queens College
Hughes, Hansel Leigh, Chemistry, Catawba College
Ingram, Roy L., Geology, University of North Carolina
Johnson, Jay W., Junior Curator, N. C. State Museum
Johnson, Willie Clifford, Entomology, N. C. State College
Jones, George D., Entomology, N. C. State College
Jones, Geraldine, Biology, Goldsboro High School
Kaufman, Clemens M., Forestry, N. C. State College
Kelman, Arthur, Plant Pathology, N. C. State College
Lawrence, Benjamin Jones, Jr., Physiology and Pharmacology, Bowman Gray School of Medicine
LeGrand, Harry Elwood, U. S. Geological Survey, Raleigh
Lewis, Anne Louise, Mathematics, Woman's College U. N. C.
Lewis, Jessica H., Physiology, University of North Carolina
McAllister, Claude Huntley, Wilmington Junior College
McComb, Clara Lee, Science, Morganton Senior High School
McFalls, Janice Seeber, Biology, Woman's College, U. N. C.
McLaurin, Angus Winston, Microbiology and Immunology, Bowman Gray School of Medicine
McMillan, John Johnson, Psychology, Duke University
Markgraf, William Frederick, Geology, University of North Carolina
Mitchell, Margaret Capehart, Biochemistry, Bowman Gray School of Medicine
Moreland, Donald Edwin, Botany, N. C. State College
Moss, Beverly C., Clinical Psychology, State Hospital, Goldsboro
Norman, John H., Chemistry, Queens College
Park, Dorothy, Psychology, Meredith College
Phillips, Coy T., Geography, Woman's College, U. N. C.
Powell, Ernest H., Jr., U. S. Fishery Laboratory, Beaufort
Powers, Maurice Cary, Geology, University of North Carolina
Preston, Richard Joseph, Jr., Forestry, N. C. State College
Query, Juanita Noland, Testing Psychologist, Samarcand Manor, Eagle Springs, N. C.
Ritcher, Paul Osborn, Entomology, N. C. State College
Scruggs, Chester A., Science, East Carolina Teachers College
Selfridge, Harry A., Engineering Office, Catawba College
Shannon, Henry Anthony, State Department of Public Instruction
Shugar, Gilbert Lee, Zoology, Duke University
Simpson, Norman Emmett, Botany, Duke University
Smith, Pauline Katherine, Biology, Greensboro College
Stains, Howard James, Zoology, N. C. State College
Stephens, Stanley G., Agronomy, N. C. State College

Tuttle, Dorothy Meyer, Microbiology, Bowman Gray School of Medicine
Tuttle, Robert Lewis, Tropical Medicine, Bowman Gray School of Medicine
Tyndall, Jesse Parker, Science, Atlantic Christian College
Walker, E. M., Campbell Junior College
Watts, George Kenneth, Science, Scotts High School
Welch, Annye Elizabeth, Mathematics, Catawba College
Wiebe, Herman Henry, Botany, Duke University
Wills, Camilla Louise, Science, Atlantic Christian College
Winslow, Edward Leigh, Jr., Institute of Fishery Research, Morehead City
Yancey, Henry, Central High School, Charlotte
Zimmerman, Alice B., Psychology, Woman's College, U. N. C.

4. The following were reinstated as members in the Academy:

Barton, Helen, Mathematics, Woman's College, U. N. C.
Beck, Clifford K., Physics, N. C. State College
Fritz, Robert Lindsay, Mathematics, Lenoir Rhyne College (Emeritus)
Ingraham, Helen Margaret, Biology, Woman's College, U. N. C.
Nahikian, Howard M., Mathematics, N. C. State College
Rosen, Nathan, Physics, University of North Carolina
Whyburn, William M., Mathematics, University of North Carolina
Zener, Karl, Psychology, Duke University

5. The Secretary reported the following losses in membership:

1. By resignation: 4
2. By non-payment of dues: 40
3. By death the following:
   Fritz John Hansgirg
   William Alexandre Perlzweig
   William Frederick Prouty

6. The Committee accepted the invitation of President A. Hollis Edens to meet at Duke University in 1951.

The above reports of the Executive Committee were adopted by the Academy.

TREASURER'S REPORT

Financial Statement as of July 1, 1950

Receipts	
Bank balance (from July 1, 1949)	$175.64
Gifts	
John Bewley Derieux Memorial Award	50.00
Ornithological Essay Award	20.00
Dues, 1949	4.00
Dues, 1950 (including new members and reinstatements)	790.00
Total	1039.64

Expenditures

Elisha Mitchell Scientific Society	300.00
Secretarial aid	100.00
Secretarial commission	80.00
High School Awards	75.00
Postage and stamped envelopes	60.72
Stationery, printing and programs (N. C. State Print Shop)	50.65
Transferred to savings account	33.47
Reprints (Waverly Press)	18.20
Expenses to meeting	12.00
Bank charges	7.12
Telephone (long distance calls)	6.75
Ruth M. Addoms (High School Committee)	5.00
Total	748.91
Bank balance	270.73
Cash on hand	20.00
	1039.64

Savings Account

Balance July 1, 1950	100.00

Total Assets

Checking account and cash on hand	290.73
Savings account	100.00
U. S. savings bonds (maturity value)	300.00
Total	690.73

On the first day of July, 1950, we, the undersigned, have examined this account and found it to be correct.

(Signed) H. T. SCOFIELD
H. V. PARK
KEY L. BARKLEY, *Chairman*

REPORT OF THE LIFE MEMBERSHIP COMMITTEE

The committee, consisting of John N. Couch, Maude Williams, and W. L. Porter, recommended that Earl Henry Hall, retired Professor of Botany at the Woman's College of the University of North Carolina, be elected to life membership.

The Academy unanimously elected this scientist to life membership.

The committee further recommended that eligibility for life membership in the Academy be based on the following criteria:

1. Retirement from profession; twenty years of membership in the Academy; and membership in the Academy at the time of his nomination.
2. Notable service to various scientific organizations.
3. Worthy contributions to science in research, teaching or public service.

It is understood that there may be circumstances in which the time requirement may be waived so far as membership in the North Carolina Academy is concerned.

The Academy accepted the report of the committee and approved a motion by

Dr. John N. Couch to dispense with the Life Membership Committee, the duties of which will be performed by the Executive Committee.

REPORT OF THE RESEARCH GRANTS COMMITTEE

The grant of $74.50 for the past year was given to Dr. W. B. Fox and Mr. R. K. Godfrey of N. C. State College. The grant was used for partial defrayment of expenses incurred in a study of the Leguminosae and Compositae of North Carolina.

B. W. WELLS
W. O. PUCKETT
A. D. SHAFTESBURY
O. C. BRADBURY, *Chairman*

REPORT OF THE POTEAT AWARD COMMITTEE

The committee met at noon on Saturday, May 8, 1950, and discussed at length the difficult problem of selecting a meritorious paper presented this year. After due consideration it was decided to grant the award to Dr. C. G. Bookhout of Duke University for his excellent paper, "Development of a marine annelid, *Dasybranchus caducus*, from egg to pre-adult."

E. W. BERRY
A. V. COBLE
D. S. GROSCH
REINARD HARKEMA
H. G. MCCURDY
T. L. QUAY
MARJORIE SWANSON
L. E. ANDERSON, *Chairman*

REPORT OF THE COMMITTEE ON HIGH SCHOOL SCIENCE

I accepted the chairmanship of this committee on condition that: a) it would last for one year only, and that b) the committee could be made up of local people so that meetings could be arranged. This procedure I recommend wholeheartedly, because a committee that can meet is much more efficient than one that has to conduct its business by mail. My committee, consisting of Dr. M. W. Johnson, Dr. H. S. Roberts, Miss Ruby Williams, and Dr. J. H. Highsmith, has worked hard and deserves recognition.

Plans were discussed in the late spring and early summer, because the committee felt it imperative that complete and clear-cut information should be available to high school teachers as early as possible in the fall.

1. The committee decided, with the approval of the President of the Academy and of the donors of prizes, to change the plan of exhibits by dividing them into classes and by offering a cash prize in each class sufficiently large ($20) to attract interest. It was the feeling of the committee that next year's committee might wish to change the classes.
2. In an attempt to make the essay competitions more interesting, the com-

mittee set a definite title for the Forestry Essays (*The Forests of North Carolina and What They Mean to My Community*) and for the Ornithology Essays (*Ways of Attracting Birds to the Home Grounds*), with the idea in mind that next year's committee would set different titles.

In the early fall mimeographed sheets describing both exhibits and essay contests were prepared. Dr. Highsmith helped materially by sending these out to the principals of all white high schools, with the request that they be referred to the science teachers. These sheets were sent out in the fall; October 1 would be the ideal time.

An announcement of the contests was made in the October issue of the magazine of the North Carolina Education Association, and a reminder was printed in the March issue (February would be better). We are indebted to Mrs. Ethel Perkins Edwards for this courtesy.

An effort was made to stimulate interest among science teachers by asking someone to announce the competitions at each of the district meetings in the fall. The committee is indebted to several members of the Academy for this service.

Essays were due on March 1. Seven Ornithology essays and fourteen Forestry essays were submitted and they were read by committees appointed by the President of the Academy.

Exhibits were to be listed with the chairman of the committee by April 15. At that time, it became necessary for the chairman to relinquish the work; and the committee graciously agreed to carry on under the chairmanship of Dr. H. S. Roberts. To my hard-working committee and to all other members of the Academy who have helped the committee, I offer my heartfelt thanks.

RUTH M. ADDOMS

Announcement of the winners of the various high school student contests was made at the evening meeting by Dr. H. S. Roberts as follows:

FORESTRY ESSAY CONTEST

(*Sponsored by N. C. Forestry Association*)

First Prize: Philip Leinback, R. J. Reynolds High School, Winston-Salem
Second Prize: Mildred Jenkins, Scotts High School, Scotts
Third Prize: Edwin Stockton II, R. J. Reynolds High School, Winston-Salem

ORNITHOLOGY ESSAY CONTEST

First Prize: Dan McIntyre, Goldsboro High School, Goldsboro
Second Prize: Billie Jean Everhart, Boyden High School, Salisbury
Third Prize: Ralph Dwiggins, Gray High School, Winston-Salem

EXHIBITS CONTESTS

Category A: Living Plants or Animals (Sponsored by Carolina Biological Supply Co.)

First Prize: Room 305, Central High School, Charlotte
"Backyard Biology"
Honorable Mention: Tony Anthony and Amos Johnston, Gastonia High School
"Live Animals"

Category B: Preserved Plants or Animals (Sponsored by Carolina Biological Supply Co.)
First Prize: Mary Poole, Central High School, Charlotte
"Insect Collection"
Honorable Mention: Sarah Luckadoo, Morganton High School
"Pressed Plants"
Honorable Mention: Kenneth Rudolph and Bevan Barrington, Boyden High School, Salisbury.
"Skeletal Preparations"

Category C: Models
First Prize: Roger Little, Central High School, Charlotte
"Model of Still"
Honorable Mention: Hubert Jack Heard and Wilson Otto Woods, Central High School, Charlotte
"Ceramics"
Honorable Mention: Mary Cole, New Hanover High School, Wilmington
"Wood Burnings of Animals"
Honorable Mention: Charles Snipes, New Hanover High School, Wilmington
"Grafting Demonstration"

Category D: Unrestricted Original Exhibits
First Prize: Sara Jo Hensley, Morganton Senior High School
"Dissectible Human Torso"
Especial Mention: Jack Baugh, Central High School, Charlotte
"Modified Automobile"
Honorable Mention: Mary Nisbet, Central High School, Charlotte
"Plastics"
Honorable Mention: Alex Efird, New Hanover High School, Wilmington
"Charts of the Animal Kingdom"
Honorable Mention: J. K. Patterson, Boyden High School, Salisbury
"Nature Photography"

REPORT OF THE CONSERVATION COMMITTEE

The committee has attempted to focus attention on four problems which should concern most of the members of the Academy. Although there are numerous other problems in need of attention, we felt that it would be more practical to select several specific ones on which we might take some action.

Therefore, we are not presenting these with the thought that they be merely recorded and placed in the minutes of this meeting. We feel that the Academy should take steps to activate and implement the following proposals.

The four problems we have selected for consideration are:

1. Need for legislative action to control the sale of Venus fly traps.

2. Need for legislative action to pass upon and control the introduction of exotic game species of animals.
3. The need for adequate appropriations to establish statewide forest fire control and to increase the technical forestry advice and assistance to the owners of small tracts of forest land.
4. Finally, the need for legislation to establish statewide regulatory control for the correction of stream pollution in the state.

We propose various degrees of action on these four proposals. In the case of the Venus fly trap and exotic game species, we feel the Academy needs to initiate the action and seek the cooperation of other groups. In the problems of forest fire control and stream pollution control, other groups have already and will continue to press for funds and legislative action and we need to assist these groups in every way possible.

Therefore, we submit the following four brief reports with resolutions attached, for your consideration and action.

I. Venus Fly Trap

WHEREAS:

The Venus Fly Trap grows nowhere else but in a restricted number of counties in the Coastal Plain of North and South Carolina. Its curious mechanism, which causes the leaf-blade to snap shut upon physical stimulus, permits the trapping of insects which are subsequently digested by enzymes which it secretes. These peculiar characteristics caused Darwin to describe the plant as the most wonderful in the world. The plant is probably known by more botanists and naturalists throughout the world than any other, and it has been the subject of study by many of them.

Fortunately, it is plentiful where it grows, and the occasional removal of a few plants has not seriously reduced its range or numbers. Now, however, a few people have started digging it for commercial purposes. Truckloads have been hauled to various cities around the State and the plants sold there on the street and in stores. Such activity, if it continues, can only mean the extermination of an unique plant—far more unusual than many others which have been protected elsewhere (orchids, for example). A related species from California was, at one time, sold in dime stores all over the country and as a result, has been almost eliminated.

It is a disgrace that a biological curiosity of this sort should be sold for the profit of a few people and at the risk of its extermination. The sale of the plant should be stopped, since it violates the spirit of conservation and there is a definite possibility that the plant may be exterminated.

Some evidence has been collected as to the extent of the sale of this plant. One person is devoting full-time to its sale and two others part-time. Thousands and thousands of plants have been sold in North Carolina cities and towns this year and thousands more shipped to New York and other places in response to orders resulting from advertisements in National and Metropolitan papers and magazines.

The presence of the trucks in our cities and towns and the sales to our school children represents the worst kind of conservation education and needs to be stopped immediately.

THEREFORE, BE IT RESOLVED:

(a) That the legislative committee of the Academy seek the cooperation of the responsible agencies in the State, principally the Department of Conservation and Development, and draft a bill for presentation at the next session of the Legislature which would prohibit its sale, provide for responsibility in protecting the plants, and impose a suitable fine for infractions of the regulations.
(b) That the Academy publicize the problem and seek the assistance of other interested groups in supporting the bill, particularly the Garden Clubs and Women's Clubs.

II. Introduction of Birds and Mammals in North Carolina

WHEREAS:

The indiscriminate introduction of wild birds and mammals from outside the State of North Carolina for release in this State constitutes a threat to our native species with which competition is bound to occur.

The successful introduction of birds and mammals, especially exotics, frequently results in serious losses to agricultural interests and often requires vast expenditures of public funds to eradicate or even control them. The armadillo recently established in Florida and the fox squirrel in California are costing those States thousands of dollars annually. The "male" Kansas jack rabbits liberated for coursing in the Sandhills area of North Carolina are still causing considerable damage to peach and apple trees fifteen years after their introduction.

Of the forty human diseases required by the North Carolina State Board of Health to be reported, birds and mammals are the only sources of seven and are an important source for two more.

Wild birds and mammals frequently serve as the reservoir for the dissemination of disease organisms and parasites of great economic importance to domestic animals.

The wild birds and mammals already in this State have undergone thousands of generations of rigorous selection incident to survival in the wild and are best adapted to our environmental conditions.

Through selection, specific genetic situations have been established for the game population of this State and the introduction of other types would promote hybridization. It is well established that crossing of different strains, races, subspecies (or even species, as is possible in certain cases), often produces abnormal size and vigor *in the first generation* hybrids followed by a corresponding tendency toward debility or defect *in succeeding generations* (if abnormality is not so extreme as to produce sterility).

There is sufficient wild breeding stock of our native species present within the boundaries of this State for transplanting and release in deficient North Carolina areas.

The introduction of wild birds and mammals into North Carolina affects the health, economy, and welfare of all the people of this State and no single agency now exists which has the personnel or facilities to handle adequately this highly technical problem and to protect the interests of all groups for the benefit and protection of the whole.

THEREFORE, BE IT RESOLVED:

(a) That the legislative committee of the North Carolina Academy of Science seek the cooperation of the North Carolina Department of Agriculture and the North Carolina Wildlife Resources Commission and the Wildlife Federation and other interested groups, to draft the necessary legislation to create a Board composed of a representative from each of the following agencies:

North Carolina Department of Agriculture
Office of State Veterinarian
State Board of Health
Wildlife Resources Commission
North Carolina Agricultural Experiment Station
A recognized ecologist from an institution of higher learning in this State.

(b) The above mentioned legislation would provide that no introductions of exotic or native wild birds or mammals would be made in this State without prior unanimous approval by this Board.

(c) That enforcement of the rulings by the Board would be through those agencies now charged with such regulatory responsibilities.

III. Forest Fire Control and Forestry Assistance

WHEREAS:

(a) Some fifty-nine per cent of our State's land area is now in forest and approximately that same percentage of our area should always remain in tree growth.

(b) What we do with our woodland will in a large measure determine our success in controlling floods, in supplying the raw materials for industry and commerce, and in maintaining the ground water level essential to profitable farming.

(c) The average forest acre in North Carolina pays annually an estimated twelve cents in county taxes, thirty cents in various State taxes, and probably at least thirty cents in various Federal taxes.

(d) Increased attention must be given to the protection of our forest resources against wild fire and against unwise forest management practices.

(e) Two-thirds of the forest land of North Carolina is held in small ownerships and wise management and utilization of our timber resources cannot be established without active cooperation of the owners of these lands.

THEREFORE, BE IT RESOLVED:

That the North Carolina Academy of Science assist in every way possible the efforts of the North Carolina Division of Forestry, the North Carolina Forestry Extension Division, and the North Carolina Forestry Association and Council, and other interested groups in:

(a) Establishing through appropriation of adequate funds a statewide forest fire control program on equal terms with neighboring states.
(b) Making available tree seedlings to reforest our estimated one million acres of idle non-agricultural land.
(c) Increasing the technical advice on forestry and assistance needed by the owners of small tracts of forest land so as to make the fullest use of the State's economy, since good forest management is absolutely essential to successful agriculture and industry in our State.

IV. Stream Sanitation

WHEREAS:

There is at present no Board, Commission, or Committee that has authority to prevent any town, city, or industry from putting raw sewage and industrial waste into the streams of the State, unless they directly affect a public water supply.

The State Stream Sanitation and Conservation Committee, set up by an Act of the 1945 General Assembly, has studied numerous corrective acts as passed by other states and presented to the 1949 General Assembly for regulatory authority a recommended bill that was felt by the Committee to be the most workable one.

The 1949 General Assembly did not see fit to pass this recommended bill, and the growth of North Carolina is rapidly increasing in both industry and population, adding a greater load of sewage to the already heavily burdened streams.

The State of North Carolina is suffering a great loss in revenue directly to the State and also to the individuals of the State due to the present conditions of some of the waters. With more domestic and industrial waste added each year, it is realized that the longer the delay for such regulatory authority the longer it will take to bring the streams and waters of the State to a useable condition.

Fish and wildlife are being destroyed by pollution and thus destroying recreation and in some cases a livelihood for the citizens of the State.

THEREFORE, BE IT RESOLVED:

By the North Carolina Academy of Science that the North Carolina General Assembly be urged to leave no stone unturned in seeing that the State Stream Sanitation and Conservation Committee be given regulatory authority for the correction of stream pollution by the passage of a bill to that effect in the 1951 session, and that the Academy actively assist all other interested groups in the passage of this much-needed legislation.

F. S. BARKALOW, JR.
H. J. OOSTING
W. D. MILLER
W. A. RILEY
J. L. STUCKEY
R. L. WEAVER, *Chairman*

The above report was unanimously endorsed by the Academy.

REPORT OF REPRESENTATIVE TO ACADEMY CONFERENCE

The Conference of State Academies of Science of the AAAS met at the Hotel New Yorker on Friday, December 30, 1949. It was called to order by the Chairman, Dr. Frank E. E. Germann. There were 33 present, of whom 14 were official delegates to the Conference.

The first speaker on the program was Dr. Howard A. Meyerhoff, Administrative Secretary of the AAAS. His subject was "Congress and the National Science Foundation." He told of the present status of the National Science Foundation and reported that its prospects of adoption by the Congress are good. This prediction has recently been realized.

The second paper on the program was presented by Dr. W. A. Macfarlane, Director of the United Kingdom Scientific Mission in North America. His subject was "The Organization of Government Science in the United Kingdom." He demonstrated that there has been a genuine endeavor by all governments in Great Britain *not* to interfere with scientists and their ways of working, while trying to help in the development of science.

Dr. Watson Davis of Science Service spoke on "A National Program for the Science Talent Search." This paper presented the accomplishments and prospects of the Science Talent Search. It was pointed out that the opportunity for home work is frequently the stimulus to becoming a scientist, that it is important to realize early in life what is the scientific method, and that science clubs lead to science fairs or congresses.

Dr. P. N. Powers of the Atomic Energy Commission presented his paper on "The Changing Manpower Picture". This paper has since been published in the March 1950 issue of *The Scientific Monthly*. It was shown very lucidly that the "shortage-of-scientists" problem, as we have known it during the past few years, is about over. There is, however, the new problem of keeping supply and demand in balance.

There was then a paper by Mrs. Madeline Fink Coutant on "The Science Congress Movement in New York State." Mrs. Coutant is on the staff of Hartwick College and is Director of the Oneonta Science Congress. High School members of that congress presented demonstrations of their work and a colored motion picture of the last congress was shown. The members of the Conference were made very conscious of the challenging opportunity envisioned by this program.

The speaker at the Academy Conference dinner was Dr. William G. Pollard, Executive Director of the Oak Ridge Institute of Nuclear Studies. He spoke on "The Oak Ridge Institute of Nuclear Studies and the Atomic Energy Programs in the Associated Universities."

REINARD HARKEMA

REPORT OF THE RESOLUTIONS COMMITTEE

Be it resolved that the North Carolina Academy of Science express to President Alvin R. Keppel, the administrative officers, the faculty, and student body of Catawba College its deep appreciation for the gracious hospitality and the many courtesies extended it at this meeting; be it resolved further that especial thanks

be extended to Professor Milton L. Braun and to the local Committee on Arrangements whose attention to details has contributed so much to this the forty-seventh annual meeting of the Academy; also, be it resolved that this report be entered into the minutes of this meeting and a copy be sent to President Alvin R. Keppel and to Professor Milton L. Braun.

EDWARD T. BROWNE

The above report was unanimously approved by the Academy.

The following memorial reports were presented at the meeting:

FRITZ JOHN HANSGIRG

Dr. Fritz J. Hansgirg died suddenly on July 23, 1949, at the age of 58. He was living in New York where he served as chief engineer for the Electro-Metal Corporation and the Bach Corporation, and consultant for the Standard Oil Company of New Jersey.

Dr. Hansgirg was born in Graz, Austria. It was here that he received his formal education, which culminated with a doctor's degree from the University of Graz. Starting as an organic chemist specializing in dyes, Dr. Hansgirg moved into the domain of oils, simultaneously into the study of electrolytic and electrothermic processes, and into the heart of metallurgy where he finally became an authority in magnesium. At the same time he became interested in catalytic reactions, a very complex field, and emerged with a new catalytic process for the production of hydrogen. Through his interest in electro-chemistry he studied the electrolytic deposition of oxides. In the midst of his work on the production of magnesium he became interested in the chemistry of isotopes and in his spare time devised a method for the production of heavy water.

The knowledge of so many fields—organic chemistry, metallurgy, electrochemistry, physics—is rather unusual. One can only admire these outstanding achievements; very few scientists have the privilege of venturing outside their own field. It has to be noted also that Dr. Hansgirg was a very fine musician, had an extraordinary knowledge of painting, and an extremely wide knowledge of literature.

His life work necessitated many business trips throughout the world where he worked and studied, built plants, produced materials, but there were many other trips when he was not an engineer or scientist, but just a man avid to know different people, customs and cultures.

In September, 1942, he joined the faculty of Black Mountain College where he erected a research laboratory, and combining his teaching with personal research he developed a process for reducing magnesium from Western Carolina Olivine. In addition he prepared the manuscript for a book on "Energy and Matter."

His students were fascinated by his immense knowledge and unlimited enthusiasm with which he colored his lectures. It was for everyone of them an experience they will never forget. He imbued them with the intellectual curiosity so exceedingly important for every student of science. For four years Black

Mountain College profited by the presence of such an extraordinary man. His human quality, refinement, and knowledge were rare.

His premature death will be felt in many areas of human activity. The scientific world loses one of the foremost experts in the metallurgy of magnesium; the industrial world loses an outstanding administrator; his friends and acquaintances feel the loss of a great teacher and a man whose intellectual and artistic refinement was a rare example of what civilization can achieve.

NATASHA GOLDOWSKI

The above memorial was approved by a rising vote.

WILLIAM ALEXANDRE PERLZWEIG

Dr. Perlzweig, first Professor of Biochemistry in the Duke Medical School, was born in Ostrog, Russia, on April 23, 1891. When 15 years old he came to this country and completed his education. He won the Bachelor of Science degree in 1913 and the Ph.D. degree in 1916 from Columbia University. He then spent a year at the Rockefeller Institute for Medical Research in New York. From 1917 to 1919 he was in the U. S. Army, commissioned a first lieutenant in the Sanitary Corps. Following his discharge, he lived in Baltimore, Maryland, working first at the Hygienic Laboratory of the Public Health Service and then as chief chemist to the medical department of the Johns Hopkins Hospital.

In 1930 he was appointed by Dr. Davison to organize the Department of Biochemistry in the new medical school at Duke University. Under his guidance the department has grown in size and in quality. Dr. Perlzweig's interests were catholic; he was ever a champion of close teamwork between the laboratory and clinic. For the past 20 years of his life, he carried forward the growth of his department and has trained many disciples whose work in various parts of the country testify his ability as a teacher and a leader. His death on December 10, 1949, after several months of illness is a great loss not only to Duke University but to North Carolina's scientific structure and to the North Carolina Academy of Science.

During his lifetime Dr. Perlzweig was active in research as well as in teaching and administration. His many publications include studies of the pneumococcal antigen, metabolic diseases, mineral metabolism, enzymes, and particularly metabolism of the members of the vitamin B complex. He counted among his colleagues and co-authors other eminent scientists such as Leonor Michaelis, Chester Keefer, Tinsley Harrison, E. S. Gusman-Barron, and Sergius Morgulis.

Dr. Perlzweig was a very lovable man; his geniality endeared him to many friends throughout this country and abroad. His colleagues at Duke Medical School will miss him not only as an able, encouraging and helpful associate but as an affectionate friend.

MACDONALD DICK

The above memorial was approved by a rising vote.

WILLIAM FREDERICK PROUTY

William Frederick Prouty, Professor of Geology in the University of North Carolina since 1919 and Head of the Department of Geology and Geography

since 1933, died on June 27, 1949. His forebears were of old New England stock and his early training and education were in that tradition. He possessed a lean and hardy frame which enabled him to carry on geological field work with a vigor and endurance envied by far younger men. As a teacher and department head, he maintained a friendly atmosphere for students and made them feel at ease and at home in the department. He was not too strict about locking doors, but rather made laboratories and equipment available to qualified students and encouraged them to work beyond scheduled hours. His students soon came to respect his interest and confidence in them and losses of materials and specimens from the department were at a minimum.

He was born in Putney, Vermont, August 15, 1879. His college education was obtained at Syracuse University, where he received the Bachelor of Science degree in 1903 and the Master of Science degree in 1904, and at Johns Hopkins University where he received the Doctor of Philosophy degree in 1906.

Prior to coming to the University of North Carolina, he had served as Chief Assistant on the Alabama Geological Survey and as Associate Professor and Professor of Geology in the University of Alabama. In 1919, he joined the faculty of the University of North Carolina as Professor of Stratigraphic Geology. In 1924, he became Professor of Structural and Economic Geology and in 1933 he succeeded Professor Collier Cobb as Head of the Department of Geology and Geography.

During the thirty years he taught at the University of North Carolina, in addition to his teaching duties, he found time to engage in geological research and consultation. He served as Geologist on the North Carolina Geological and Economic Survey from 1920 to 1924, as Paleontologist on the West Virginia Geological Survey from 1922 to 1925 and as consultant with the Tennessee Valley Authority from 1938 until his death.

His first important research was on the Silurian of Maryland, which served as his doctoral dissertation. At intervals thereafter, he wrote papers on the Silurian of the Southern Appalachians, the last of which was published in 1941. He was interested in the Triassic formations of North Carolina and the structure of folded mountains and published papers on these subjects. His chief interest, however, was in Economic Geology and it was in this field that he did his major research. As an Economic Geologist he did outstanding work on (1) the bedded iron ores of Alabama, (2) the marbles of Alabama, Tennessee and Maryland, (3) the Coosa Coal Field of Alabama and (4) the graphite deposits of Alabama. It should also be noted that he shared authorship in three folios of the Geological Atlas of the United States.

In his latter years he became greatly interested in the origin of the "Carolina Bays." He was a believer in the meteoric theory of their origin, and his long and careful investigations gave it strong support. Most of his work on the Carolina Bays remains unpublished. At the time of his death, he had just completed the first draft of an extensive paper, which, when published, will no doubt have an important influence upon geological opinion concerning the origin of the Bays.

On June 9, 1909, he married Lucile W. Thorington of Montgomery, Alabama, daughter of a former Dean of the Law School of the University of Alabama, who

survives him together with their three sons: Frederick Morgan Prouty, William Walker Prouty, and Chilton Eaton Prouty.

Soon after coming to the University of North Carolina, he became a member of the North Carolina Academy of Science and regularly took an active part in its programs. He served as President of the Academy in 1931. The Academy has lost a valuable colleague and friend and the family a devoted husband and father.

JASPER L. STUCKEY
WILLIAM A. WHITE.

The above memorial was approved by a rising vote.

REPORT OF THE NOMINATING COMMITTEE

The committee, consisting of O. C. Bradbury, Chairman, M. L. Braun and F. G. Hall, submitted the following nominations:

President: A. S. Pearse, Duke University
Vice-President: E. L. Mackie, University of North Carolina
Member of the Executive Committee: E. C. Cocke, Wake Forest College
Members of the Research Grants Committee: Ruth M. Addoms, Duke University, and G. R. MacCarthy, University of North Carolina

There being no nominations from the floor, the Secretary was asked to cast the ballot and declare the nominees elected. This concluded the business and the meeting was adjourned.

At 6:00 p.m. the members enjoyed a complimentary barbecue supper given by Catawba College. At 8:00 p.m. the evening session was held in the Auditorium of the Main Building, with Vice-President W. O. Puckett presiding. The winners of the various High School Student Contests were announced by Dr. H. S. Roberts. Dr. Puckett presented President Alvin R. Keppel of Catawba College who welcomed the Academy to the Campus. President C. F. Korstian then presented his informative and interesting address, "Growing Successive Crops of Pine in North Carolina." The members then adjourned to the Student Union where they were entertained by the wives of the Catawba College Faculty.

The sectional meetings were well attended. The following officers were elected for the respective sections:

Biochemistry and Physiology: Chairman, K. M. Wilbur and Susan Gower Smith; Secretary, Marjorie Swanson.
Botany: Chairman, Lewis E. Anderson; Secretary, W. B. Fox.
Geology: Chairman, R. L. Ingram; Secretary, E. W. Berry.
Mathematics: Chairman, D. C. Dearborn; Secretary, H. B Hoyle, Jr.
Psychology: Chairman, Key L. Barkley; Secretary, Marion Stanland.
Wildlife: Chairman, Win Donat; Secretary, W. L. Hamnett.
Zoology: Chairman, H. K. Townes; Secretary, D. S. Grosch.

The following constitute the personnel of the standing committees:

Executive: A. S. Pearse, E. L. Mackie, Reinard Harkema, A. F. Thiel, C. H. Bostian, E. C. Cocke.
Research Grants: W. O. Puckett, A. D. Shaftesbury, G. R. MacCarthy, Ruth M. Addoms.

Dr. A. S. Pearse, President of the Academy for 1951, announced the appointment of the following committees:

Auditing: Key L. Barkley, H. V. Park, H. T. Scofield.

Conservation: R. L. Weaver, B. W. Wells, F. S. Barkalow, W. D. Miller, Coy T. Phillips.

High School: Inez Coldwell, Charlotte Dawley, Jane C. Frost, Hollis Rogers, H. A. Shannon.

Legislative: Harry T. Davis, R. L. Weaver, J. L. Stuckey.

Nominating: J. W. Lasley, Jr., F. G. Hall, C. F. Korstian.

Poteat Award: D. S. Grosch, E. W. Berry, W. B. Fox, W. L. Hamnett, Reinard Harkema, H. B. Hoyle, Jr., Marion Stanland, Marjorie Swanson.

Resolutions: O. C. Bradbury.

Representative on A. A. A. S. Council: D. P. Costello.

Representative to Academy Conference: D. P. Costello.

Constitution: H. L. Blomquist, H. R. Totten, Reinard Harkema.

John Bewley Derieux Memorial Award: Anna Joyce Reardon, O. J. Thies, Jr., Nathan Rosen.

Approximately 350 members and guests registered during the meetings.

The following papers were presented during the meetings. Those marked with an x are abstracted in these proceedings:

GENERAL SESSIONS

Addresses of Welcome. President A. R. KEPPEL and Dean D. C. DEARBORN, Catawba College.

Presidential Address: Growing successive crops of pine in North Carolina. C. F. KORSTIAN, Duke University.

x*The fundamental action potentials developed in the lobes of Venus' fly-trap due to a stimulus.* OTTO STUHLMAN, JR., U. N. C.

The Cape Fear region in late Pleistocene. B. W. WELLS, N. C. State.

x*Translocation of radioactive phosphorus in loblolly pine* (Pinus taeda *L.*) D. E. MORELAND, N. C. State.

x*A Study of the permeability of certain epidermal membranes to gaseous carbon dioxide.* W. M. DUGGER, N. C. State.

Aeration and water absorption. P. J. KRAMER, Duke (Read by title only).

Inhibition of bacterial cell division by anticoagulants. JOHN R. WARREN and FRED W. GRAHAM, Duke.

The seasonal succession of orthopteran stridulation near Raleigh. B. B. FULTON, N. C. State.

Screwworm outbreaks and its activity. G. D. JONES, N. C. State.

The effect of pentathal sodium on the ascorbic acid level of the whole blood of man. A. E. A. HUDSON, N. C. State (Read by title only).

Transfusion via the bone marrow route. HENRY TURKEL, Detroit, Mich. (Read by title only).

The physics of color television. H. A. SELFRIDGE, Catawba.

BIOCHEMISTRY AND PHYSIOLOGY SECTION

Evaluation of peripheral circulation in man by means of constant temperature studies and use of radio-sodium. CREED MCFALL, H. D. GREEN, RICHARD POLLITZER, and MICHAEL MOORE, Bowman Gray.

Experimental studies on leptospirosis. P. R. BEAMER, Bowman Gray.

Constancy of responses to intra-arterial injection of mecholyl in the isolated, blood-perfused extremity: Perfusion with a pump-oxygenator system. B. J. LAWRENCE, JR., A. B. DENISON, JR., J. M. LITTLE, and H. D. GREEN, Bowman Gray.

x*Tissue activators of a serum enzyme.* JESSICA H. LEWIS and J. H. FERGUSON, U.N.C.

Decarboxylation of cysteic acid. J. C. ANDREWS and J. F. R. KUCK, U.N.C.

Enzymatic disappearance of formaldehyde in the presence of pyruvate. PEGGY MITCHELL and CAMILLO ARTOM, Bowman Gray.

Studies on dimethyl ethanolamine as a possible intermediate in choline metabolism. MARIETTA CROWDER and CAMILLO ARTOM, Bowman Gray.

Biochemical studies on several strains of Histoplasma capsulatum. A. W. MCLAURIN and DOROTHY TUTTLE, Bowman Gray.

The nicotine content of breast milk from cigarette smokers. W. A. WOLFF and J. F. DONNELLY, Bowman Gray.

The action of various metallic ions on the phosphatases of liver. MARJORIE SWANSON, Bowman Gray.

BOTANY SECTION

Some observations on plant succession in thinned pine stands of the Piedmont. S. G. BOYCE, N. C. State.

Effects of soil sterilization on survival of grass seedlings. FELTON NEASE, Duke.

An enumeration of noteworthy distributional records for North Carolina Compositae R. K. GODFREY, N. C. State.

Notes on the distribution of North Carolina plants. W. B. FOX and R. K. GODFREY, N. C. State.

Notes on Isoetes in North Carolina. A. E. RADFORD, U. N. C.

The rushes of North Carolina. WADE BATSON, Duke.

Technique of preserving and mounting blue-green algae (Demonstration). E. C. COCKE, Wake Forest.

Additions to the State list of fresh-water algae. L. A. WHITFORD, N. C. State.

Gemmae in Lophocolea heterophylla *(Schrad.) Dum.* H. L. BLOMQUIST, Duke.

A new species of Mnium from North Carolina. LEWIS E. ANDERSON, Duke.

The effect of mineral oil upon lateral buds of tobacco. D. B. ANDERSON, N. C. State.

x*Storage of isolates of* Pseudomonas solanacearum *under mineral oil in relation to virulence.* ARTHUR KELMAN and J. H. JENSEN, N. C. State.

The conditions which determine the formation of sporangia in some organisms related to Streptomyces. JOHN N. COUCH, U. N. C.

GEOLOGY SECTION

Roundness changes in Cape Fear River sand. R. L. INGRAM and M. C. POWERS, U. N. C.

Geological investigation aids mineral production. J. L. STUCKEY, N. C. State.
Lightweight aggregate and glass fiber from Florida phosphates. POOLE MAYNARD, Atlantic Coast Line Railroad.
Mineral changes in the weathering of Triassic Dikes near Chapel Hill, N. C. W. F. MARKGRAF, M. C. POWERS and J. R. RECKNAGAL, U. N. C.
x*A Cretaceous log jam.* E. W. BERRY, Duke (Read by title only).
x*A megascopic roundness scale.* M. C. POWERS, U. N. C.
The Capture Cycle. W. A. WHITE, U. N. C.
x*Some geological observations in Caldwell and Watauga Counties, western North Carolina.* T. R. GOEDICKE, U. N. C.
x*A discussion of red granites.* GLENN E. MCKINLEY, N. C. State.
Geological control of drainage in the slate belt of Stanley and Cabarrus Counties, North Carolina. F. O. BOWMAN, JR., U. N. C.

MATHEMATICS SECTION

On the fundamental theorem of conformal mapping. W. J. CARPENTER, Western Carolina Teachers College.
Some whys and hows of teaching mathematics. WHITFIELD COBB, Guilford.
Solving verbal problems in algebra. R. L. FRITZ, SR., Lenoir-Rhyne.
A method of finding irrational roots of algebraic equations. H. B. HOYLE, Queens.
Some remarks on Stokes' Theorem. H. M. NAHIKIAN, N. C. State.
The number of genera of binary quadratic forms with even discriminant. ANNYE ELIZABETH WELCH, Catawba.
The circular and hyperbolic functions. W. M. WHYBURN, U. N. C.

PSYCHOLOGY SECTION

(N. C. Psychological Association)

Presidential Address: Some tentative suggestions toward improvement of methodology in learning research. KARL ZENER, DUKE.

WILDLIFE SECTION

An economic survey of North Carolina's wildlife resources. H. J. STAINS, N. C. State.
Observations on the seasonal and geographic distribution of the squirrel warble (Cuterebra *sp.*) *in North Carolina.* RAY ALLISON, N. C. State.
Some natural history museum techniques for school use. JAY W. JOHNSON, N. C. State Museum.
Age, sex and weight ratios of mourning doves in North Carolina. T. L. QUAY, N. C. State.
Mortality in bass and sunfish subsequent to capture and release. J. H. CORNELL and W. E. ELLIS, Wildlife Resources Commission.
Deer disease in North Carolina. B. F. COX, N. C. State.

ZOOLOGY SECTION

x*Development of a marine annelid,* Dasybranchus caducus, *from egg to pre-adult.* C. G. BOOKHOUT, Duke.

Notes on immature stages of Lucaninae (Coleoptera: Lucanidae). TOM DAGGY, Davidson.

Some postembryonic changes in the digestive tract of the worker honeybee. T. M. DOBROVSKY, N. C. State.

x*Cytological aspects of the spinning glands of the parasitic wasp, Habrobracon, from Feulgen preparations.* D. S. GROSCH, N. C. State.

x*A preliminary study of lens regeneration in* Pseudacris nigrita feriarum. E. C. HORN, Duke.

x*The inheritance of ectrodactylism. Part II. Statistical tests of alternative hypotheses of its inheritance.* C. D. HOWELL, Catawba.

Contributions to the life history and morphology of the trematode, Gynaecotylea adunca (*Linton, 1905*). WANDA SANBORN HUNTER, Duke.

x*Phosphorus exchange in the shell of the oyster.* LOUISE H. JODREY and K. M. WILBUR, Duke.

x*Experimental production of pulmonary artery anomalies in chick embryos.* M. W. JOHNSON and L. J. MANHOFF, JR., Duke.

The fauna of the reefs off the Carolina coast. A. S. PEARSE, Duke.

N. C. SECTION OF AMERICAN CHEMICAL SOCIETY

A novel application of the Diels-Alder reaction. PELHAM WILDER, Duke.

Preparation of some fluoroisoquinolines. C. E. TEAGUE, JR., and ARTHUR ROE, U. N. C.

Reactions in the m-terphenyl series. C. K. BRADSHER and I. SWERLICK, Duke.

The activity coefficients of sulfuric acid in aqueous 2-propanol solutions at 25°. H. D. CROCKFORD and J. E. LAND, U. N. C.

Heat capacity of $K_3Fe(CN)_6$ and $K_3Co(CN)_6$ from 15–300°K. CHARLES MORROW, U.N.C.

The physical properties of some fluorine compounds. MARCUS HOBBS and LEONARD CHERRY, Duke.

The determination of the dissociation constants of the monofluoroquinolines from spectrophotometric measurements. W. K. MILLER and S. B. KNIGHT, U. N. C.

Synthesis of organic compounds containing Iodine 131. R. L. HAYES and ARTHUR ROE, U. N. C.

Attempts to detect an isotope effect of Carbon 14. MAX HELLMAN and ARTHUR ROE, U. N. C.

Metallic cation effects in reactions of bases with organic compounds. F. W. SWAMER and C. R. HAUSER, Duke.

The Lactobacillus Bulgaricus factor, an unidentified bacterial vitamin. W. L. WILLIAMS, N. C. State.

Microbial studies on the L. Bulgaricus factor and the relationship of the factor to known vitamins. R. A. MCRORIE and W. L. WILLIAMS, N. C. State.

Concentration of the L. Bulgaricus factor and its chemical nature. P. M. MASLEY and W. L. WILLIAMS, N. C. State.

Abstracts:

The Fundamental Action Potentials Developed in the Lobes of Venus' Fly-trap Due to a Stimulus. OTTO STUHLMAN, JR.

The Venus' fly-trap, *Dionaea muscipula*, is included in a small group of plants designated by botanists as carnivorous because of its reputed ability to digest insects and small bits of living matter caught in the trap structure from which the plant takes its popular name.

J. Burdon-Sanderson as early as 1873 discovered "The Electromotive Properties of the Leaf of Dionaea in the Excited and Unexcited States." With the aid of a capillary electrometer he was able to record, as a result of stimulating the inner surface of a lobe, a short-lived positive electrical increase followed by a larger negative rise and fall in potential when the electrodes were placed symmetrically on the two outer surfaces of the trap. The electrical transient was found by him to last about one second and its propagation speed, at 38°C was about 20 cm per sec.

In order to compare modern results of neural action potentials with the bioelectrical action potentials obtained by Burdon-Sanderson, it is not enough to identify the local negative potential transients but one must investigate the variation of the negative and positive after-potentials with instruments that will not produce distortions in these electrical transients.

Bioelectrical pulses, which as in Dionaea were found to last for several tenths of a second, can become highly distorted even if ordinary modern resistance-coupled amplifier circuits are used. It was found necessary to modify the differential-dc-amplifier described by Schmitt in order to adapt it for use as a dc amplifier if the direct-coupled stages of a Dumont 208 B cathode-ray oscillograph are to be used.

The connections between the metallic input circuit and the surfaces of the leaf were bridged by non-polarizable Ag-AgCl electrodes in 0.7 per cent KCl solution.

The stimulus to excite the bioelectrical activity, though not sufficient to produce mechanical closure of the trap, was applied by suddenly bending one of the trigger hairs. The resulting bio-electrical potential pulse was amplified distortionless and the oscillograph record was photographed by synchronizing the stimulus with the camera shutter.

The start of the action potential was gradual; there was no evidence of a sudden or explosive change although the initial acceleration was very great. The negative rising phase is smooth and its crest is reached in about 1/10 sec. The falling phase is much slower so that the peak as in neural spike potentials is situated well towards the side of the rising phase. Immediately following the spike, as in neuron compound action potentials, there occurs a negative after-potential, next comes the positive after-potential. The latter attains its maximum value in about 0.07 sec. and then decreases until restoration to its resting potential is completed in about 1.5 seconds.

If the action potentials were picked off at successively greater distances from the point of stimulation, the transients broaden and become lower. The compound action potential is resolvable into two components, one attributed to a transient comparable to the neural C-action-potential of unmyelinated mammalian nerve fibers and the other to the movement of an electrolyte associated with the hydrodynamic reactions of the lobes in closure.

Lantern slides made from the original oscillograph curves were used to illustrate the successive stages of the analysis.

A Study of the Permeability of Certain Epidermal Membranes to Gaseous Carbon Dioxide. W. M. DUGGER.

It has been generally understood by biologists that the exchange of gases between the internal tissue of plants and the external atmosphere only occurs to an appreciable extent when the stomates or other natural apertures are open. If this were true, closure of the openings, such as stomates, should largely prevent exchange of carbon dioxide between the plant tissue and the atmosphere.

Although there is considerable indirect evidence that epidermal walls are permeable to carbon dioxide, no comprehensive study of this matter has been previously undertaken.

The study that has been completed involves the use of non-stomated leaf, root and fruit tissue and the determination of their epidermal penetration by carbon dioxide using radioactive carbon as a tracer.

An enclosed gas release-flow-absorption method is described in conjunction with the results obtained.

In the leaf studies glass cups were sealed to the upper surface of the leaves of several species known to have stomates only on the lower leaf surface. Radioactive carbon dioxide in concentrations of 1, 5, and 10 per cent was circulated through these cups for a 4-hour period. The quantity of carbon dioxide penetrating the epidermal layers was determined by the use of Geiger counters and by radioautographs. Experiments were carried out with illuminated leaves and in darkness.

Similar experiments were performed with cup attached to the lower surface of leaves when stomates were closed and when stomates were open to determine the relative rates of penetration under those conditions.

The results of these experiments indicate that the amount of carbon dioxide diffusion through non-stomated epidermal membranes is a large fraction of the amount diffusing through the stomated epidermis.

In the root studies radioactive carbon dioxide was bubbled through the solutions in which roots of several species of plants were growing. The penetration of carbon dioxide into roots was determined by testing sections of roots with Geiger counters and by the use of radioautographs. From the results it is obvious that carbon dioxide gas does penetrate the uncutinized epidermal cells of roots. The majority of the gas remains in the gaseous phase in the intercellular spaces and can be easily removed by evacuation into a weak base.

The fruit studies involved the use of ripe and green tomato fruits. These were exposed to radioactive carbon dioxide in sealed containers for short periods of time. Sections of the fruit were tested by the usual method for the presence of radioactive carbon dioxide. The results indicate that the non-stomated epidermis of tomato fruit is permeable to carbon dioxide, a matter of considerable fundamental importance, particularly in relation to problems of storage of living plant tissues.

Tissue Activators of a Serum Enzyme. JESSICA H. LEWIS and JOHN H. FERGUSON.

A quantitative survey of a large number of animal tissue fractions, prepared by differential centrifugation, indicates a widespread distribution of a *fibrinolysokinase* (factor which activates serum prolysin to fibrinolysin enzyme). The "large granule" and "microsome" fractions (Claude) particularly show this activity and it is not extractible with ordinary solvents. A dog lung fraction (IV + VI) was selected for some special studies.

The tissue lysokinase is moderately heat labile and best preserved frozen at −20°C. It requires time for maximal effect on profibrinolysin and the rate of activation and final fibrinolysin yield are modified by temperature, concentration of kinase, deterioration of formed lysin, and by antilysin (if present). Serum and plasma are activated by tissue lysokinase with difficulty, but dilution lessens the "antilytic" effect. Antilysin is also demonstrable in some tissue fractions, but no prolysin. Human, dog, and bovine prolysins have been prepared free from antilysin and with little or no active lysin appearing either "spontaneously" or after treatment with chloroform (lack of a *serum* lysokinase?). When these three prolysins are tested with lung fractions from 8 species all are activated, in some degree, by most of the tissue lysokinase preparations, without evidence of the species specificity seen with the similarly-acting bacterial kinases. The successful, if partial (?), activation of bovine prolysin is noteworthy in view of previous inability to find a bacterial activator for this species.

The crude tissue preparations often contain factors which act on blood-clotting mechanisms, especially antithrombin and thromboplastin. By taking advantage of the greater thermolability of lysokinase and the "antithromboplastic" action of heparin, the thromboplastic and fibrinolysokinase activities of the tissue fractions can be separated experimentally.

Storage of Isolates of Pseudomonas solanacearum *under Mineral Oil in Relation to Virulence.* ARTHUR KELMAN and J. H. JENSEN.

Loss of virulence in culture is a characteristic of the plant pathogen, *Pseudomonas solanacearum* E. F. S., causal agent of southern bacterial wilt. An evaluation of the mineral oil method as a means of maintaining pathogenic cultures of this important parasite has been made over a four-year period. In 1945 virulent isolates were obtained from diseased potato, tobacco, and peanut plants. Stock cultures were made by covering 48-hour cultures of these isolates on potato-dextrose agar slants with a layer of sterile mineral oil (medicinal grade). Pathogenicity experiments were conducted at least once each year using sub-cultures of the original slants as the sources of inoculum. Eight or ten Marglobe tomato seedlings were inoculated by stem puncture for each isolate. Disease indices based on numerical rating of symptoms served as a means for comparison of relative pathogenicity in successive years. At periodic intervals comparison of stock cultures was made with new isolates obtained from diseased plants. In most instances virulence of inoculum from oil-covered isolates was comparable to that of these new isolates. In 1949 several cultures stored under oil for 4 years were only slightly less pathogenic than a fresh, highly virulent isolate obtained from

a diseased tobacco plant. The experiments demonstrated that virulence of *P. solanacearum* is relatively stable when stored for long periods of time on potato-dextrose agar slants covered with sterile mineral oil.

A Cretaceous Log-Jam. E. W. BERRY.

On Willis Creek west of North Carolina Route 87 in Cumberland County, North Carolina, there are exposed some 17 carbonized logs in place and numerous fragments. Most of the logs are carbonized with more or less pyrite; some are silicified, but only a few. The logs range in diameter from two to four feet. The longest one is exposed for 32 feet and bridges a tributary to Willis Creek. There is no set orientation, they point in all directions. On this same tributary are a series of beds inclined about 35° which are probably foreset beds. The region represents a delta in late Black Creek time (Upper Cretaceous).

A Megascopic Roundness Scale. M. C. POWERS.

A new roundness scale and a new technique of determining roundness have been proposed. Six class limits, instead of the previously used five, are used in this roundness scale. The new class limit occurs in the lower roundness values and is easily differentiated because of this position. The new term proposed was "Very Angular". A simpler method for determining the roundness value for a sedimentary sample is also proposed. This method has been used in laboratory work and found to be as accurate as other methods. It offers the advantages of six class limits over the previously used five. It does not necessitate the use of a comparison chart after the first 100 or so grains.

Some Geological Observations in Caldwell and Watauga Counties, Western North Carolina. T. R. GOEDICKE.

A description is given of the geology of an area of 20 square miles surrounding the property of the Yadkin Valley Ilmenite Co. in Caldwell County, based on a preliminary survey. A preliminary map shows approximate geological relations and contacts.

The metamorphic rocks of the area are of late pre-Cambrian age and consist of quartz-sericite phyllites, biotite gneisses and schists, amphibolites and quartzites. There are also large areas of granite gneiss, apparently a migmatite formed as the result of the invasion and absorption of the metamorphic rocks by magmatic ichors from depth.

In the northern part of the map area there occurs much blue slate of presumed volcanic origin, interbedded with quartzitic bands. It is believed that most of the foliated rocks were formed as the result of metamorphism of this series of volcanics and sediments. The regional schistosity has an average attitude of N 35° E and a dip of 50–60° SE.

The ilmenite occurrences of the area as well as the pegmatite dykes are thought to have originated a little later than the migmatites and to have come from an allied source.

A Discussion of Red Granites. GLENN E. MCKINLEY.

Several intrusions of red granite occur in the western part of the Wichita Mountains in southwestern Oklahoma. In many instances, distinction and correlation is difficult. This situation made it necessary to use a simple method of acid treatment of the granites which resulted in more positive identification of the various rock units.

The igneous rocks are Pre-Cambrian in age and outcrop as islands, with near horizontal Permian "red-beds" deposited in the hollows of the rugged erosional Pre-Cambrian surface. Successive granite intrusions are found cutting through an older basement of gabbro-anorthosite. They occur as sills and perhaps laccoliths. The area involved in a test of the acid treatment method is approximately seven hundred and fifty feet high and four square miles in area. At present eight granites have been recognized. All are leuco-granites with the exception of one which is a hornblende, biotite granite. Each rock type varies considerably in texture. This is particularly true of those having the greatest outcrop area. Because of the ever present red color, resulting from the presence of red or pink orthoclase and/or hematite staining, it is often impossible to distinguish rock types in a single outcrop by field examination alone. In the large outcrops one can usually establish the presence and relative age of the different granites by the standard dike and inclusion relationships. Difficulty arises when one leaves that outcrop and goes on to the next, particularly if the latter is some distance away and small. Identification and differentiation was attempted by utilizing heavy mineral separation, possible distinctions in texture and composition from thin sections and saw-cut slabs, all resulting in still uncertain correlation.

The acid treatment method was finally employed with noteworthy success. It involved selecting the freshest samples, crushing each to approximately five to ten millimeters, rinsing in distilled water and then placing in a four hundred milliliter beaker. The sample was allowed to fill about one-third of the beaker, which was then filled about two-thirds full of fifty per cent hydrochloric acid and boiled for at least four hours. Solution had to be added regularly and in several samples the iron content seemed so great that during the four-hour period such samples were rinsed and covered again with the fresh acid solution. Between eight and ten samples were checked during a setting by using a sand bath. Known samples were checked and without exception each recently mapped rock type from the larger outcrops (those in which the type and age relationship were felt to be certain) was found always to be primarily composed of only one of the following: red, flesh pink, or white orthoclase. Using this as a basis, smaller and more distant outcrops were sampled, checked in the laboratory, and mapped with greater certainty. In conclusion, this method was definitely an aid to correlation. It served as a means of subdividing the granites into one of three groups, depending on the true color of the feldspar.

Development of a Marine Annelid, Dasybranchus caducus, *from Egg to Pre-Adult.* C. G. BOOKHOUT.

Eggs are deposited in plum-shaped jelly masses, become ciliated embryos in

8 hours, and trochophores in 24 hours. The latter is characterized by two red eyes, apical tuft, and green pigmented bands between a prototroch and telotroch. At two days a neurotroch appears, and at three days larvae emerge from the jelly to become part of the plankton. They are positively phototropic and negatively geotropic. After 7 days they settle; at 9 or 10 days they lose their cilia and undergo metamorphosis. Development of fertilized eggs removed from the coelomic cavity show that jelly is not necessary for early development, nor does it hasten metamorphosis.

The best indication of age of larva and stage of juvenile is the condition of the setae. A notopodial and neuropodial winged seta develops simultaneously on each side in segments 2–4 at the 4th or 5th day. By the time of metamorphosis there are two winged setae per bundle in segments 2–4, and a single notopodial and neuropodial hooded uncinus on each side in segments 5–7. Post-larval development involves the occurrence of winged setae and the loss of uncini in thoracic segments. An increase in uncini in abdominal segments results in 4 tori per segment. The differentiation of sense organs, nervous system, digestive system and other internal organs is discussed.

Cytological Aspects of the Spinning Glands of the Parasitic Wasp, Habrobracon, from Feulgen Preparations. D. S. GROSCH.

The present report is based on whole mount preparations of male larvae and pupae of known age and determined size. The organisms were dissected in a rapid single operation using a pair of needles, immediately fixed with Gilson's fixative, and stained by the Rafalko modification of the Feulgen technique. Through these methods the delicate spinning or "silk" gland was often obtained intact and its distal bifurcation disclosed (branched structure was omitted from a diagram previously published in this Journal **65**: 62). Although anteriorly the structure may appear more than once per transverse section due to its sinuous arrangement, posteriorly its two or even more appearances per transverse section are traceable to the bifurcation.

Cytological details, some of them unexpected and surprisingly similar to situations found in ciliated protozoa, were discovered as follows:

(1) Organization at the cytological level is not based on a uninucleate cell. Units containing four large nuclei predominate in glands of mature larvae. Occasionally a 5- or 6-nucleate unit can be found. This is in comparison to the situation in first instar larvae where the units not quadrinucleate contain 2 or 3 nuclei.

(2) Amitotic divisions of nuclei are seen in first and second instar larvae, which suggests the method whereby the quadrinucleate units are constituted. However, the total number of nuclei in a spinning gland is found to be over 400 in first instar larvae and between 450 and 500 in mature larvae indicating little amitotic nuclear division during larval development. Therefore it is proposed that the major organization of structural units in the SG occurs in the embryo or during the hatching period. In fact no more than one amitotic figure per gland has been seen on any single slide of a young larva.

(3) On the other hand, during degeneration of the gland (larva in cocoon) amitotic division followed by nuclear fragmentation is general.

(4) The duplication of nuclear contents during the tremendous growth in nuclear size attending larval development resembles endomitotic processes.

(5) Nuclei in full-sized larvae contain a large number of small stainable elements which become clumped accompanying nuclear vacuolization when larvae assume spinning activities. Ultimately the individual objects of the clumps become indistinguishable. Similar events occur in the nuclei of other larval structures destined to undergo histolysis but the inception is later than in the spinning gland, hence the contrast in nuclear situations depicted in the Journal of Morphology **86**: 153–176, 1950.

A Preliminary Study of Lens Regeneration in Pseudacris nigrita feriarum. EDWARD C. HORN.

The ability of larval *Pseudacris nigrita feriarum* to regenerate a lens from the dorsal margin of the iris (Wolffian regeneration) was tested by removing the left lens at five different stages during the development of the tadpoles. The earliest stages tested (Shumway 24) showed the opercular folds just closing; the latest (Taylor and Kollroe VI) possessed a paddle-shaped hindlimb bud without demarcation of toes.

The operated animals were killed at intervals up to the tenth day after operation for the youngest operative stages and up to the twentieth day for the oldest stages. Stained serial sections of the head region of each experimental animal were made.

Within the time limits listed above for the stages used the data indicated that no regeneration from the iris had occurred. In the few cases which showed regeneration of a lens, the rapidity with which a new lens formed and its position in the eye indicated its source from lens fragments formed at the time of operation rather than from the iris margin.

The Inheritance of Ectrodactylism. Part II. Statistical Tests of Alternative Hypotheses of its Inheritance. CHARLES D. HOWELL.

Fifteen affected individuals had 44 normal sibs, making a total sibship of 59 persons. In 13 families, not one parent of affected children was affected. Four affected parents had 12 normal, but no affected children.

A recessive gene was first considered as responsible for the trait. Making a correction for over-selection of recessives, it was found that 21 affected would have been expected instead of 15. The difference is large, but 20% of data at random could be expected to have as big a deviation. There were 10 marriages of unrelated parents with affected children out of about 1,000 marriages of the descendants of the apical progenitors of the family. These marriages of carriers would be expected in 4 of 100,000 marriages if the trait were recessive and seen in 1 in 100,000 of the population. The 1/100 observed is much too high.

Next, the possibility that a dominant gene with low penetrance is involved was considered. In this case the appearance of the trait would hinge upon the frequency of the gene only in descendants of the apical progenitors and would not involve the frequency outside the family. Every affected individual found was a descendant of one couple. Penetrance of 50%, 25% and 12.5% were successively

considered. The first two did not fit all the observed facts, but 12.5% fitted well all three categories as follows: (1) sib ratio—expected 16 affected, 43 not affected; observed: 15:44. (2) Frequency of the trait in parents of affected children—expected 1.6 out of 13 pairs; observed 0 out of 13. (3) Frequency of the effect in children of the affected parent—expected 0.75 in 12; observed 0 out of 12.

Unless population studies reveal this trait as being much more common than we now suspect, the assumption of dominance with low penetrance has an advantage over simple recessiveness in accounting for the appearance of the trait in the families observed.

Phosphorus Exchange in the Shell of the Oyster. LOUISE H. JODREY and KARL M. WILBUR.

Shells of the oyster, *Ostrea virginica*, when placed in sea water containing radioisotopes exchange atoms in the shell for labeled atoms in the solution. Ion exchange must be considered as a factor in shell formation and has been studied using radioactive phosphorus.

The amount of P^{32} exchanged is not uniform over the inner surface, certain areas consistently showing greater exchange than others. In all areas P^{32} deposition at first rises rapidly and then reaches an equilibrium. When the radioactive shells are placed in non-radioactive sea water, the removal of P^{32} proceeds in a similar manner, falling rapidly at first and then reaching an equilibrium. However, all the P^{32} is not removed in the same period required for its deposition. Apparently a portion of the radioactive phosphorus has been changed to a non-labile form.

Deposition of P^{32} was compared at 10° and 38°C. At the higher temperature the rate and extent of deposition are considerably greater; and, in contrast to shells at 10°, equilibrium is not usually reached in a 40-hour experimental period. The exchange is reversible at 10°, whereas a non-labile form is produced at 38°. The existence of a temperature coefficient and the formation of a non-labile form of phosphorus indicate the presence of some process other than simple exchange.

Experimental Production of Pulmonary Artery Anomalies in Chick Embryos. M. W. JOHNSON and L. J. MANHOFF, JR.

The causes which determine differences in embryonic blood vessel disposition are of interest to biologists.

A direct experimental method of duplicating certain spontaneously-occurring anomalies should be of value for (a) determination of developmental steps leading to adult patterns and (b) furnishing adequate numbers of specific anomalies for study of possible corrective surgical procedures.

A method is described by which certain pulmonary artery anomalies are produced. Electric coagulation of the right 6th visceral arch tissue in chick embryos (age—77 hrs.) results in either stenosis of the right pulmonary artery or a complete absence of it. In the latter case, blood supply of the right lung may be through a branch from the systemic arch.

Further use of this experimental method for attack on other problems is discussed.

REINARD HARKEMA, *Secretary*

474TH MEETING, OCTOBER 11, 1949

ALFRED T. BRAUER (Mathematics): *Limits for the Characteristic Roots of a Matrix.*

H. G. BAITY (Sanitary Engineering): *A Sewage Disposal Plan for the City of Montevideo, Uruguay.*

This paper describes the investigations which were made to develop a suitable system of sewage collection and treatment at Montevideo, Uruguay, to relieve the present pollution and avert future damage to the water-front developments of this area, which constitute one of the most important resources of that country.

475TH MEETING, NOVEMBER 8, 1949

NATHAN ROSEN (Physics): *Gravitational Waves.*

MAURICE WHITTINGHILL (Zoology): *An Investigation of Changes in Gene Linkage Values by the Use of Gamma Rays.*

In genetics the tendency for transmitting some genes in the parental assortments (linkage) comes from the fact that these genes are in the same chromosome. New combinations may be formed by crossing over, which has been attributed to exchanges occurring during meiosis. Some external agents alter the values of the recovered exchange products, chief among them X-rays and temperature extremes. In Drosophila males the crossovers induced by these agents originate before meiosis. The distribution of these exchanges in males is concentrated toward the spindle attachment, as shown in my recently computed spermatogonial map. This may also apply to the other sex and explain the altered crossover values there found. Several experiments were performed while the author was a research participant at the Biology Division of the Oak Ridge National Laboratory to test the ability of another mutagenic agent, gamma rays, as an inducing agent and to try to find the *modus operandi*. After irradiation with 4000 r crossover values were increased regularly throughout the major length of the chromosome, greatest near the spindle attachment, in a pattern already known for high temperatures and other agents. In addition, coincidence values for each region were computed from the multiple crossovers and were found to have increased in all regions as follows: very slightly in the most distal regions, progressively more in regions nearer the spindle attachment, and greatest of all in the spindle region. These two findings were what had been predicted on the hypothesis that some of the crossings over were induced in oögonial cells before the usual time for spontaneous crossing over. Furthermore, there was a slight amount of clustering of different kinds of crossovers in different families. Induced clustering was then reinvestigated in experiments with two special stocks whose synthesis and use in the author's "autoclassifying" crossover-selector system has been described before this Society. From gamma-irradiated Star Lobe^4/Curly

Pufdi females the clustering was of an extreme sort which could be expected only in 1/1000 experiments if resulting from independent meiotic formation. Much more probably such a distribution of crossovers among families was the result of a little oögonial crossing over and multiplication in varying amounts. Similar irradiation of Minute-y Glued/Stubble bithorax^{D} males was followed by the appearance of clusters of crossovers which were clearly of spermatogonial origin. Gamma rays thus appeared to have acted directly upon gonial cells in the two special stocks and probably also in regular rucuca heterozygotes.

476TH MEETING, DECEMBER 13, 1949

R. C. MITCHELL (Geology): *Concerning the Core of the Earth.*

The core of the Earth represents about 0.4 of the total radius, the periphery being considered to lie at a depth of 2900 km.

The studies of R. D. Oldham first yielded scientific data regarding the core. Between 90° and 150° from the point of origin of earthquakes, he found that S and P waves underwent a marked decrease in velocity of propagation, the rate of decrease of the former type of wave being greater. Of the two suppositions regarding the S waves, Oldham categorically denied that such waves were extinguished in the core.

Later work by Gutenberg and others showed that the 'shadow zone' lies between 102° and 143°, and that waves refracted through the core can arrive at any point more distant from the locus of origin than about 143°. These waves are the P′ ones, condensational waves of greater energy than P waves.

The problem of the S waves resolves itself into two schools of thought. One school maintains that from certain earthquake records, they definitely have established the occurrence of shear or S waves, and from this, postulate that the core is solid. The other school argues that the core is liquid, as no S waves penetrate it. The decision regarding the physical state of the core must be left to the future.

The core consists of 90% Fe, 5% Ni, .76% Cu and .57% Co, some 27 other elements comprising the remainder. It is the high percentage of the heavy metallic alloys which account for the 77% of the total Earth mass, whilst the silicate shells total only 23%.

Certain interesting speculations can be made from studies of the core: (a) If there is no sudden increase in density at the core boundary, perhaps convection within the core may be responsible for terrestrial magnetism. (b) It would be of great value to test instrumentally if there is a 'lag' in the axis of rotation of the core with respect to the mantle in the Earth's precession, for if such is so, then the characteristics of seismic waves would be altered and our concepts must be changed accordingly. (c) With increase in depth, likely the melting point increases more rapidly than the temperature, and hence temperatures at depth would prevent crystallization, hence solidification, hence rigidity. The importance of such in petrological theories, such as magma genesis, magmatic movements, magmatic eruptions, etc., may indeed have interesting implications.

LYTT I. GARDNER, M.D. (Biochemistry): *The Effect of Dietary Phosphate Load on the Newborn Infant.*

Review of 16 cases of neonatal tetany revealed that all were fed cow's milk formulas. Analyses of human and cow's milk confirmed previous data that cow's milk has a high concentration of P and a low Ca/P ratio. Breast fed newborns showed little variation in daily serum inorganic P determinations, but cow's milk fed infants showed levels of serum P and Ca similar to values found in neonatal tetany, with maximum P values on the 6th to 8th day of life. The per square meter P intakes of newborns fed cow's milk exceeded that of the average adult, and were within the range known to cause elevated serum P and depressed serum Ca and Mg values in dogs. The association of cow's milk ingestion with neonatal parathyroid hyperplasia is suggested by a correlation of Kaplan's histological study of newborn parathyroids with diet ingested by infants of his series (cf. Arch. Path. **34:** 1042, 1942). Complete metabolic data on a cow's milk fed newborn showed elevation of serum P, depression of serum Ca and Mg, and marked increase in urinary P as compared to the breast fed newborn. When Ca lactate was added to the formula serum P, Ca and Mg returned to normal. Balance data showed more positive Ca and less positive P, Mg and N balances than in the pre-Ca lactate periods. When added Ca was withdrawn these balances returned to foreperiod levels, and serum Ca and Mg values again fell. Renal P clearance in face of increased serum P with dietary P load in the first week of life was found to be less than 10% of reported glomerular filtration rate for the newborn. These findings point to the high P content of cow's milk as a major etiologic factor in many cases of neonatal tetany and emphasize the suitability of human milk for the human newborn.

477TH MEETING, JANUARY 10, 1950

OSCAR K. RICE (Chemistry): *Thermodynamics of Liquid Helium.*

Gaseous helium condenses at atmospheric pressure, at a temperature slightly above 4°K, to a liquid whose properties appear to be entirely normal. At 2.19°K, the so-called λ-point, however, it undergoes a remarkable transformation. This is a second-order transition, which has no latent heat and no change in volume. The specific heat, however, rises to a large value, has a discontinuity, and then below the λ-point, falls off rapidly. The coefficient of expansion also shows a discontinuity. The flow properties of liquid helium show a remarkable change below the λ-point. The liquid practically loses its viscosity, and becomes a "superfluid". It flows over the surfaces of glass containers. It becomes a highly efficient conductor of heat.

About twelve years ago London suggested that these properties were connected with the fact that helium atoms obey the Bose-Einstein statistics. The λ-point transition was assumed to have a connection with the fact that in a Bose-Einstein ideal gas there should occur a special type of condensation in momentum space, in which a finite fraction of the molecules goes into the lowest energy level. This seems to be confirmed by the properties of the recently investigated isotope,

He^3, which obeys the Fermi-Dirac statistics, and hence should not show any effects which can be connected with the Bose-Einstein condensation. That this is true has been verified down to about 1°K.

On the basis of London's theory, it was suggested by Tisza, and later on other grounds by Landau, that below the λ-point helium consists of a mixture of two phases, one of these being ordinary liquid helium such as is known above the λ-point, and the other superfluid in essentially the state in which it exists at 0°K. This hypothesis was found to be capable of explaining many of the peculiar properties of liquid helium.

The present discussion deals principally with the thermodynamics of liquid helium in the light of the two-fluid theory. In particular the thermodynamic consequences of assuming these two phases to be in equilibrium are discussed. It is pointed out that there is some evidence that these phases are separated in ordinary space as well as in momentum space. The specific heat just above the λ-point is considered on the assumption that in this region superfluid is beginning to appear in the form of small globules; it is estimated that these globules contain around 60 to 80 helium atoms. The thermodynamic properties below the λ-point are used to estimate the entropy of mixing of the two fluids in this region. The results suggest that in this region the superfluid forms a "partially condensed system", having possibly a fibroid structure. The nature of the second-order transition at the λ-point is considered in the light of this picture. A new relation is derived for the change of the λ-point with pressure, and the change with concentration of the isotope He^3 is also considered. The thermodynamic results, though discussed in the light of the hypothesis that the two phases separate in ordinary space as well as momentum space, depend for the most part only on pure thermodynamics and the mere existence of two phases.

CHARLES W. HOOKER (Anatomy): *Blood Levels of the Ovarian Hormone, Progesterone.*

Although the hormones are considered to be blood-borne regulators of various bodily functions, information with respect to concentrations in the blood is scanty. In collaboration with Dr. T. R. Forbes at Yale University a bio-assay has been developed that regularly detects 0.0002 microgram of the ovarian hormone, progesterone. The test is specific in the sense that twenty-odd related compounds failed to provoke the response upon which the test is based.

A study of blood of the rabbit, the mouse, the monkey, and man revealed that the hormone is present only in the plasma, that roughly 90 per cent is free and 10 per cent bound or conjugated, and that in the presence of an active corpus luteum a plasma concentration of the order of 6.0 μg/ml is typical.

During pregnancy in the mouse, a relatively high level of plasma progesterone was found in the first nine days. Thereafter the level fell steadily, except for a sharp rise and fall on the thirteenth and fourteenth days. A physiologically ineffective level was found during the three days preceding delivery. The assumption has usually been that the blood level rises steadily throughout pregnancy and falls off sharply at parturition.

In the monkey low levels were found during the first half of the menstrual cycle. A transitory increase occurred at the middle of the cycle. During the latter half of the cycle a comparatively high level was found. At the onset of menstruation the blood level decreased sharply.

With respect to the metabolism of progesterone, it has been found that the bound fraction in plasma is biologically inert and that binding is at least one of the mechanisms of hepatic inactivation of progesterone in the mouse. Other sites of inactivation were found to be the kidney and the blood plasma itself. Upon circulation through the kidney blood lost 14 to 97 per cent of its progesterone. The progesterone was not excreted as such or as pregnanedial. Evidence was obtained that blood plasma contains an enzyme system that converts progesterone into another compound.

478TH MEETING, FEBRUARY 14, 1950

J. J. WRIGHT and C. G. SHEPS (Public Health): *The Present Status of Syphilis Control in the United States.*

E. D. PALMATIER (Physics): *Cosmic Rays at Low Altitudes.*

The genetic relationship between the soft (electronic) component and the hard (mesonic) component of cosmic radiation at sea level was discussed, the essential part of the picture being that the soft component arises primarily as a secondary radiation of the hard component. The principle techniques of using a Geiger counter telescope to separate these components were explained.

An accurate knowledge of the intensities of these different components is of importance, for it enables us to obtain some idea of the meson decay process in which electrons are produced. The results of the author's work supported the picture that the mu meson decays into an electron and two non-ionizing particles the nature of which is as yet unknown.

479TH MEETING, MARCH 7, 1950

T. F. HICKERSON (Mathematics): *String Lining Railroad Curves for Smoother Riding.*

Under the impact of traffic, railway track tends to creep slowly out of line. This irregularity may become noticeable, particularly on curves where the lateral shock and sway in the high speed trains is unpleasant to passengers.

The trend toward higher speeds for both freight and passenger operation makes it more important than ever to maintain the track continuously in good alignment.

A simple method for securing a smooth riding curve, known as "string lining," has become standard practice during recent years. Four steps enter into the procedure:

1. Marking the outer rail at equal intervals (called stations) throughout the curve.

2. With a strong linen fishing line, of length equal to two stations, measure the middle ordinates at each station in turn.

3. Adjust the measured middle ordinates (called ordinates) to determine the inward (or outward) "throw" of the track at each station for uniformity of ordinates. It is desirable that the ordinates along the central (circular) portion of the curve be *equal*, while those along the approach and run-off curves should vary by equal increments from a full ordinate at the point of full curvature to a zero ordinate at the tangent.

4. Setting stakes for establishing the new positions of the track.

The sum of the adjusted ordinates and the original (measured) ordinates for any one curve should remain the same. But a great number of sets of adjusted ordinates may satisfy this requirement. These have been found by numerical cut-and-try tabulations that may necessitate a number of trial solutions.

The aim of this paper is to present the algebraic background of the factors involved so that the effect of a change in an ordinate at any station on the "throw" at a subsequent station may be formulated. Accordingly, after having written out a desirable set of ordinates, one may calculate the theoretical "throws" that will bring about this condition. It is usually necessary that the resultant throws at the initial and final stations (those on the tangents) should be zero. If the final calculated throw (an accumulated quantity) on the tangent is not zero, then it can be reduced to zero in one operation by a change in two or more preceding ordinates.

Let m_1', m_2', m_3', m_4', etc., represent the original (measured) ordinates at stations, 1, 2, 3, 4, etc., while m_1, m_2, m_3, m_4, etc., are the corresponding "adjusted" ordinates at these stations, and the differences d_1, d_2, d_3, etc., are:

$$d_1 = m_1 - m_1', \; d_2 = m_2 - m_2', \; d_3 = m_3 - m_3', \text{ etc.}$$

Let t_1, t_2, t_3, t_4, etc., represent the "throws" at stations 1, 2, 3, 4, etc., while Δm, Δd, and Δt are the respective changes in m, d, and t at any station.

Making use of the geometrical principle "a line joining the midpoint of two sides of a triangle is equal to one-half the third side," it follows that a throw at any station will produce a change in the ordinates at the two adjacent stations equal to one-half the throw, and of opposite sign.

Hence

$$m_1 = m_1' + t_1 - \tfrac{1}{2}t_2, \tag{1}$$
$$m_2 = m_2' + t_2 - \tfrac{1}{2}t_1 - \tfrac{1}{2}t_3, \tag{2}$$
$$m_3 = m_3' + t_3 - \tfrac{1}{2}t_2 - \tfrac{1}{2}t_4, \text{ etc.} \tag{3}$$

Then

$$d_1 = m_1 - m_1' = t_1 - \tfrac{1}{2}t_2, \tag{4}$$
$$d_2 = t_2 - \tfrac{1}{2}t_1 - \tfrac{1}{2}t_3, \tag{5}$$
$$d_3 = t_3 - \tfrac{1}{2}t_2 - \tfrac{1}{2}t_4, \text{ etc.} \tag{6}$$

And then if $t_1 = 0$, we have

$$t_2 = -2d_1 \tag{7}$$
$$t_3 = -4d_1 - 2d_2 \tag{8}$$
$$t_4 = -6d_1 - 4d_2 - 2d_3, \text{ etc.,} \tag{9}$$

In general,

$$t_n = 2(n-1)d_1 - 2(n-2)d_2 - \ldots - 2d_{n-1} \tag{10}$$

Letting Δd_k and Δd_p represent the changes in the d's at stations k and p respectively, then the change in t at the nth station is

$$\Delta t_n = -2(n-k)\Delta d_k - 2(n-p)\Delta d_p \tag{11}$$

Thus if $\Delta d_k = +1$ and $\Delta d_p = -1$, Δt_n (the change in the throw at station n) becomes

$$\Delta t_n = -2(n-k) + 2(n-p) = 2(k-p). \tag{12}$$

W. H. HARTUNG and H. D. SMITH (Pharmacy): *The Odors of Diarylalkanes.* (Published in this issue)

480TH MEETING, APRIL 11, 1950

J. C. MORROW (Chemistry): *Low Temperature Heat Capacity and Entropy of* $K_3Co(CN)_6$ *and* $K_3Fe(CN)_6$.

The heat capacities of $K_3Fe(CN)_6$ and $K_3Co(CN)_6$ have been measured from 15° to 300°K. $K_3Fe(CN)_6$ exhibits an anomaly with a maximum near 131°K. The estimated entropy change for this non-isothermal transition is 0.91 ± 0.20 cal/deg/mole. The transition is ascribed to change in population of electronic energy levels. For crystalline $K_3Fe(CN)_6$, the entropy at 298.16°K is 100.86 ± 0.20 cal/deg/mole. The entropy of crystalline $K_3Co(CN)_6$ at 298.16°K is 96.00 ± 0.20 cal/deg/mole.

W. R. STRAUGHN (Bacteriology): *Mechanism of Action of Antihistaminics in a Bacterial System.*

Growth of *Klebsiella pneumoniae* in a synthetic salts-glucose medium was greatly stimulated by small amounts of histamine ($25 - 100 \times 10^{-6}$M). Pyribenzamine, under the test conditions, completely inhibited growth at a concentration of 200×10^{-6}M and was partially inhibitory at concentrations of 25 to 100×10^{-6}M or less. Results obtained when histamine and pyribenzamine were combined in various proportions indicated that the pyribenzamine inhibition is not a competitive one. Constant ratios of histamine and pyribenzamine did not yield equal growth inhibitions or stimulations. Similar results were obtained with histidine in place of histamine and also using histadyl as the antihistaminic.

481ST MEETING, MAY 9, 1950

S. A. VORA (Mathematical Statistics): *Bounds on the Distribution of Chi-Square.* (This was the Coker Award paper.)

VICTOR A. GREULACH (Botany): *Maleic Hydrazide as a Plant Growth Inhibitor.*

Although maleic hydrazide was synthesized by Curtius and Foesterling in 1895, it was not until 1949 that Schoene and Hoffman reported that this substance, used in concentrations of around 2000 p.p.m., would strongly inhibit

plant growth without causing marked injury or death of the plants. Following this discovery a number of botanists and other plant scientists initiated experiments designed to secure additional information on the rather unique effects of maleic hydrazide on plant growth. In the paper presented to the Society the literature was reviewed, but in this abstract a resumé will be given of only the work which has been done in the laboratories of the Department of Botany at the University of North Carolina.

The writer found that maleic hydrazide inhibited the growth of tomatoes, lima beans, peas and wheat, and that the use of a wetting agent did not increase its effectiveness except with wheat. The tomatoes were younger when treated than were those of Schoene and Hoffman, and the growth inhibiting effects were much more marked than they observed. In both tomatoes and sunflowers the maleic hydrazide inhibited the lateral as well as the terminal growth of the stems. The tomatoes developed abundant anthocyanin on the under sides of their leaves, and the leaves were much smaller and less highly divided than usual.

In experiments conducted by the writer and Earlene Atchison it was found that maleic hydrazide inhibited the growth of onion roots suspended in it by inhibiting mitosis, but apparently not cell elongation.

In another group of experiments conducted by the writer it was found that older tomato plants were not inhibited as much in growth as the younger ones used in the first experiment and that 500, 1000 and 2000 p.p.m. inhibited growth, while 1, 10 and 1000 p.p.m. had no significant influence on growth. The three higher concentrations also inhibited reproductive development, and 1000 and 2000 p.p.m. completely inhibited fruit, but not flower, formation. A 1000 p.p.m. solution of maleic hydrazide inhibited the growth of the stems, but not of the hypocotyls, of etiolated bean plants, but concentrations of 1, 10 and 100 p.p.m. had no effect.

In other experiments it was found that maleic hydrazide applied to a single leaf of lima bean and squash plants inhibited growth of the plants, as was also the case when maleic hydrazide was injected into the pith cavity of the first internode of squash plants. These results indicate that maleic hydrazide is translocated by the plant to the terminal bud, where the growth inhibition occurs. Further evidence along this line is derived from the fact that tomato seedlings were completely inhibited in growth when maleic hydrazide was placed on the sand culture media in which they were growing.

Sidney Johnson, a graduate student, found that maleic hydrazide caused neither positive nor negative curvatures of *Avena* coleoptiles, providing additional evidence that maleic hydrazide inhibits cell division rather than cell elongation. He also failed to find any inhibiting effect of maleic hydrazide on various bacteria, fungi, or algae, nor did it inhibit the growth of mice or mice tumors. Although preliminary, these results indicate that the growth-inhibiting effects of maleic hydrazide may possibly be restricted to the higher plants. Another graduate student, Miss Winifred Compton, is conducting an extensive study of the effects of maleic hydrazide on mitosis and cell enlargement in pea seedlings.

Dr. O. K. Rice, Chairman of the Nominating Committee, presented the following:

President—D. P. COSTELLO (Zoology).

Vice-President—P. E. SHEARIN (Physics).

Associate Editor of the Journal—G. R. MACCARTHY (Geology).

The above officers were unanimously elected.

A. E. RADFORD, Sec.-Treas.

HERPETOLOGICAL NOTES FROM EASTERN NORTH CAROLINA[1]

By William B. Robertson and Edwin L. Tyson

This report is based upon collections of amphibians and reptiles made in eastern North Carolina during the summer of 1948. The junior author and Mr. Lester Harris collected in Pitt County (in the vicinity of the former's home near Greenville) on several dates between June 19 and July 1, and intensively from July 7 to 20. This work was done as part of a field course for Washington Missionary College, Takoma Park, D. C., and the specimens were deposited there. From July 22 until September 3 the authors attended the Duke University Marine Laboratory at Beaufort. Opportunity was taken during this time to collect at several localities in Carteret County, North Carolina, with special effort being made to investigate the herpetofauna of the offshore banks. Collections were made August 18 on Core Bank at Cape Lookout, and August 21 on Shackleford Banks. Additional short periods were spent in collecting around Mullet Pond, Shackleford Banks, on several other occasions. On August 28 and September 4 and 5, collections, consisting largely of salamanders, were made at cypress swamp localities in Pitt County. Additional specimens were secured by the junior author in the spring and summer of 1949.

Little previous work has been done in the Pitt County region of eastern North Carolina, where our collecting centered. The most recent account of the herpetology of the state (C. S. Brimley, 1939–1943) gives definite Pitt County records for only nine species: *Eurycea longicauda guttolineata*, *Plethodon c. cinereus*, *Scaphiopus h. holbrookii*, *Bufo t. terrestris*, *Pseudacris brimleyi*, *Pseudacris n. nigrita*, *Pseudacris ocularis*, *Elaphe obsoleta quadrivittata*, and *Clemmys guttata*. Brandt (1936) adds *Hyla femoralis* to this list. Brimley (op. cit.) mentions 18 additional species as occurring generally over the state, or throughout the coastal plain: *Amphiuma means*, *Eurycea bislineata cirrigera*, *Desmognathus fuscus auriculatus*, *Plethodon g. glutinosus*, *Bufo woodhousii fowleri*, *Hyla crucifer*, *Hyla v. versicolor*, *Rana clamitans*, *Rana catesbeiana*, *Anolis carolinensis*, *Sceloporus undulatus hyacinthinus*, *Leiolopisma laterale*, *Eumeces fasciatus*, *Coluber c. constrictor*, *Lampropeltis g. getulus*, *Thamnophis o. ordinatus*, *Agkistrodon c. contortrix*, *Chelydra s. serpentina*, and *Terrapene c. carolina*. These are thus included in the fauna of the county by inference, but it is not likely that Pitt County specimens of many of them have been collected. It is obvious from the above lists that previous collecting in the county has been of a casual nature. The present report confirms twelve of the species listed from the general area but not definitely from Pitt County, and adds records for 20 additional species and subspecies not mentioned above.

Pitt County lies in the lower North Carolina coastal plain on both sides of the

[1] Contribution from The University of Illinois Natural History Museum and the Department of Zoology, University of Illinois; and the Department of Zoology, State College of Washington.

Tar River. The smaller streams of the county, with the exception of Little Contentnea and Swift creeks, flow into the Tar River. These two creeks, along the first of which much of our collecting was done, drain southward into the Neuse River. The topography and vegetation are typical of the coastal section. Wells' (1928) account of vegetational succession in the coastal plain is applicable to the area. Uplands not in cultivation are at various stages in the old field succession, or in pine or oak-pine woods. Bottomland tracts along the Tar and Neuse rivers, and their tributaries, are occupied by extensive cypress-gum swamps (*Taxodium distichum*, *Nyssa aquatica*, and *N. biflora*). Collecting in uplands was generally poor, due, at least in part, to the prevailing summer drouth. A few snakes, notably *Lampropeltis g. getulus*, *L. calligaster rhombomaculata*, *Coluber c. constrictor*, and *Crotalus h. atricaudatus*, were taken in pine woods or along roads adjoining them. In the swamps, collecting was more successful, especially in late summer when low water levels allowed access to many normally flooded sites.

The collection here reported contains 127 specimens representing 42 species and subspecies. Examples of two additional species were seen, but no specimens obtained. These are distributed as follows: salamanders, 44 specimens of seven species; frogs and toads, 40 specimens of eight species; lizards, 13 specimens of five species; snakes, 21 specimens of 17 species; turtles, nine specimens of five species. Included are 24 specimens from Carteret County, three from Greene County, one from Hyde County, and 99 from Pitt County.

The authors wish to express their appreciation to Dr. Hobart M. Smith for advice and encouragement given throughout the preparation of this paper, and for the use of his herpetological library. Drs. L. M. Ashley and D. M. Brown of Washington Missionary College, and Dr. Joseph R. Bailey of Duke University merit our thanks for their kind cooperation in making specimens from the collections of their respective institutions available to us for study. Dr. W. L. Engels of the University of North Carolina graciously allowed examination of specimens of *Natrix sipedon engelsi* from his personal collection. Specimens listed as "WMC" are at Washington Missionary College, Takoma Park, District of Columbia; other catalogue numbers refer to specimens in the Museum of Natural History, University of Illinois, unless otherwise specified.

CAUDATA

Amphiuma means Garden. Congo eel.

A single specimen (WMC) was taken at night ten miles west of Greenville, Pitt County, from a small stream in a marshy pasture. The species is recorded by Brimley (1939) as common in the coastal region, but it has not previously been definitely listed for Pitt County.

Desmognathus fuscus auriculatus (Holbrook). Dusky salamander.

Twenty-three specimens were obtained in Pitt County: two (WMC; 5204) from Little Contentnea Creek, ten miles west of Greenville on September 4,

and a series of 21 (12, WMC; 5180–88) from Chicod Creek, near Grimesland, on September 5.

This species was the most abundant salamander along the muddy streams in cypress-gum swamps. At the Grimesland locality several individuals were found under or in almost every log investigated.

Since Bishop (1943, p. 195) states that little is known of the breeding habits of this subspecies, our observations of six nests found at the above locality may be worthy of note. The globular egg-masses comprising from 14 to 20 eggs (as nearly as they could be counted *in situ*) were located in cavities *within* well-rotted cypress logs and stumps. All contained active larvae about ready to emerge. In all cases logs and stumps housing nests were located immediately at the edge of Chicod Creek or of small pools connecting with the creek. Females were found curled around all egg masses except one. These "brooding" females made no effort to escape, in marked contrast to the behavior of other individuals. Placement of the eggs appears to differ from the usual habit of *D. f. fuscus* and *D. f. brimleyorum* both of which are reported to deposit eggs under stones or logs, or occasionally under loose moss or bark on fallen logs (Bishop, 1941, p. 316).[2]

Brimley (1939) reports the present subspecies from ". . . the whole state east and south of Raleigh." Pitt County, however, seems to mark the approximate northern limit of occurrence of typical *auriculatus*, since Dunn (1926, p. 93) regards a specimen from Lake Drummond (extreme southeastern Virginia) as a *fuscus-auriculatus* intergrade. In North Carolina Dunn (*loc. cit.*) reports intergrading populations from Raleigh, Wake County, Kinston, Lenoir County, and Magnolia, Duplin County; and (*op. cit.*, p. 101) typical *auriculatus* from Grimesland, Pitt County, and four other localities in coastal counties of southeastern North Carolina.

Examination of our series of 23 adults, ranging in length from 57 to 101 mm., seems to confirm the allocation of Pitt County specimens to *D. f. auriculatus*. Considerable variation exists in the series in the amount of ventral pigmentation shown, and in the intensity of the dorsal ground color, but comparison with specimens of *D. f. fuscus* from New York, Maryland, southern Indiana, and southern Illinois shows the Pitt County specimens to be generally darker. The most distinctive feature separating them from *D. f. fuscus* seems to be the patterns of spotting (orange-red in life) on the back, tail, and sides of the body. The features of the typical patterns and variations present in our series are as follows:

1) There is a double row of large dorsal spots usually one costal space in width and separated by one or two costal spaces. Behind the hind legs these rows merge to form a single stripe along the tail keel. This pattern is best shown in smaller adults, but is well-developed on several of over 90 mm. length. In a few small specimens of under 70 mm. the spots are joined to form dorsal stripes.

[2] Since work on this report was begun, an account of one nest of *D. f. auriculatus*, in Richmond County, Georgia, has been published (Neill and Rose, 1949). This nest was located in a shallow soil depression under a scrap of bark, a situation similar to that sometimes used by *D. f. fuscus*. It contained only six eggs.

2) Another double row of light spots is discernible on each side from behind the front legs to the middle of the tail. These are present on all specimens except a few brightly marked individuals in which the upper row is largely incorporated with the expanded dorsal spots.

3) The color and width of the orbitotemporal "desmognath" mark varies greatly in our series. In specimens showing high development of the above dorsal and lateral pattern, it is wide and of similar orange-red color. In most of the specimens the stripe is narrow and lighter, while in the darkest individuals it is completely obscured.

No approach to the above described patterns was found in specimens of *D. f. fuscus* examined.

Plethodon glutinosus glutinosus (Green). Slimy salamander.

Six specimens of this species (4, WMC; 5189–90) were collected at Little Contentnea Creek, ten miles west of Greenville, Pitt County, on September 4. All were found under logs on slopes above a cypress swamp.

Stereochilus marginatus (Hallowell). Margined salamander.

Four specimens were collected at two Pitt County localities: two (WMC; 5191) from Little Contentnea Creek, ten miles west of Greenville on August 28, and two (WMC; 5192) from Chicod Creek near Grimesland on September 5. All specimens were found under logs in extremely muddy, recently flooded areas of cypress swamp. These specimens are the first reported for Pitt County, Brimley (1939) having recorded the species from similar habitats in other coastal-plain counties.

The four specimens respectively measure 84, 86, 90, and 95 mm. in total length. All are typical with 18 costal grooves.

Eurycea bislineata cirrigera (Green). Two-lined salamander.

Six specimens were taken: five (2, WMC; 5193–95) from Little Contentnea Creek, ten miles west of Greenville, Pitt County, on September 4, and one (5196) from Chicod Creek, Grimesland, Pitt County, on September 5.

All specimens were found under logs or dead leaves on moist slopes above cypress swamps. The two following species and *Plethodon g. glutinosus* also occupied this habitat.

Eurycea longicauda guttolineata (Holbrook). Long-tailed salamander.

A single specimen of this species (WMC) was collected September 4, ten miles west of Greenville, Pitt County. The species is apparently not common here, as no other specimens were seen.

Manculus quadridigitatus (Holbrook). Dwarf salamander.

Three specimens (WMC; 5197–98) were found September 4 in the same locality and habitat as for the preceding species. These are the first specimens reported from Pitt County, and represent a slight northward extension of the known range of *M. quadridigitatus* in the immediate coastal area. The four other North

Carolina localities for the species are Raleigh, Wake County, Kinston, Lenoir County, Magnolia, Duplin County (Brimley, 1939), and Lake Waccamaw, Columbus County (Mittleman, 1947).

We have elected to retain the binomial for this species in the present account, since a recent paper (Neill, 1949) has reported much confusing variation in the characters used by Mittleman (*op. cit.*) in his diagnosis of three proposed subspecies. Neill found specimens from the upper coastal plain of Georgia and South Carolina impossible to allocate subspecifically.

Our three specimens present the following characters: Total length (mm.), 55, 47, and 48; number of costal grooves, 16, 15, and 15; number of costal grooves between adpressed toes, 3, 2, and 2; combined count of vomerine teeth, 11, 10, and 9. On the basis of these characters the specimens would be referable to *M. q. quadridigitatus*, as defined by Mittleman. This is to be expected from his distribution map.

SALIENTIA

Scaphiopus holbrookii holbrookii (Harlan). Spadefoot toad.

A single DOR specimen (not saved) was found August 7 on the road leading into the Duke Marine Laboratory, Pivers Island, Carteret County.

Bufo woodhousii fowleri (Hinkley). Fowler's toad.

Five specimens were collected: four from Carteret County, Shackleford Banks, August 14 (5200), August 20 (5201), and August 30 (5202); Cape Lookout, Core Bank, August 18 (5203); and one from Pitt County, ten miles west of Greenville, August 28 (5199).

Specimens from Shackleford and Core Banks were taken on the "sound" side of the banks among small dunes grown to sea oats (*Uniola*), and under beach drift at high tide mark. Brimley (1940) calls *B. w. fowleri* the common North Carolina toad. Engels (1942, p. 293) found the species to be common on Ocracoke Island, and the only amphibian represented there; and Brandt (1936) reported it to be abundant and generally distributed in Beaufort County.

In view of these reports it is difficult to understand the range map given by Wright and Wright (1949, map 14, p. 207) which appears to exclude *B. w. fowleri* from nearly all of the North Carolina coastal plain.

Acris gryllus gryllus (Le Conte). Cricket frog.

Cricket frogs are common along lowland streams and around small ponds in pine woods. Three specimens were collected: two from ten miles west of Greenville, Pitt County, on July 16 (WMC), and on August 28 (5205); and one (5206) from two miles south of Newport, Carteret County, on August 16.

Brimley (1940) distinguishes *A. gryllus* and *A. crepitans* in North Carolina, the former largely restricted to the coastal plain. Our specimens agree with his description of North Carolina *gryllus*. Number 5206, a recently metamorphosed specimen in which the tail is still present, clearly shows the diagnostic characters (two post-femoral dark stripes, absence of anal warts) used by Netting and Goin (1945) in separating *A. g. dorsalis* of peninsular Florida.

Hyla squirella Latreille. Southern tree frog.

Two specimens of this species are in the collection. One (5207) collected on Shackleford Banks, Carteret County, August 20; the other (WMC) from Pitt County, July 15.

The species is not previously on record for Pitt County, but is recorded from many coastal counties, and from the "banks" at Cape Hatteras, Dare County (Brimley, 1940). Engels (1942) mentions its possible former occurrence on Ocracoke Island. The Shackleford specimen was found on a tree trunk in a yaupon-prickly ash-juniper thicket several hundred yards southeast of Mullet Pond.

Rana catesbeiana Shaw. Bull frog.

Two specimens of this abundant species were taken in Pitt County: one (WMC) from Little Contentnea Creek, ten miles west of Greenville, on July 5; and one (5208) in a cypress swamp near Grimesland, September 5.

Rana clamitans Latreille. Green frog.

The species is common along upland streams in Pitt County. Nine specimens were taken, all from a small branch of Little Contentnea Creek, ten miles west of Greenville, Pitt County: eight (WMC) July 15, and one (5209) August 28.

Rana palustris LeConte. Pickerel frog.

Two specimens from Little Contentnea Creek, ten miles west of Greenville, Pitt County: one (WMC) July 15, and one (5210) August 28, represent the first county records. They were taken along a small upland stream in a marshy pasture. Both show extensive dark mottling on the venter.

R. palustris seems much less common than either *R. clamitans* or *R. pipiens sphenocephala* in the coastal region of North Carolina.

Rana pipiens sphenocephala (Cope). Southern leopard frog.

The species is represented in our collection by 15 specimens from the following localities: Little Contentnea Creek, ten miles west of Greenville, Pitt County, ten specimens (9, WMC), July 15, and one (5211) August 28; Chicod Creek, near Grimesland, Pitt County, three specimens (WMC; 5212–13), September 5; near Newport, Carteret County, one specimen (5214), August 28; and Mullet Pond, Shackleford Banks, Carteret County, one specimen (5215), August 20.

Leopard frogs were the most abundant anurans at all collecting sites, being equally common along swampy pasture streams in Pitt County, around sink holes in pine flatwoods near the coast, and in the cattail marsh at Mullet Pond (fresh to slightly brackish water).

Although Brimley (1940) gives records for nearly all coastal counties our specimens are apparently the first from Pitt County.

Occurrence of frogs on the outer banks is limited by the presence of permanent fresh water ponds. Published records exist for Cape Hatteras, Dare County, and Coues (1871) mentions the occurrence of two species of *Rana* on Shackleford

Banks. These are not identified, but it seems likely that one of those referred to was *R. p. sphenocephala*. A later report (Coues and Yarrow, 1878) lists no ranid except a puzzling record of the wood frog (under the name *Rana temporaria sylvatica*).

Our specimens from all localities agree in possessing such suggested characters of *R. p. sphenocephala* as a white dot in the center of the tympanum, relatively long, pointed snouts, and few dorsal dark spots, which are often sub-quadrate and usually without light edging.

Microhyla carolinensis (Holbrook). Narrow-mouthed toad.

Two specimens (WMC; 5216) were taken on Shackleford Banks, Carteret County, August 21. Both were found under small decaying logs in open live oak woods. They showed a bright-brick red dorsal coloration in life which has disappeared in preservative. Another specimen was collected by the junior author at the Greenville airport, Pitt County, in June 1949.

The species has apparently not been previously noted from either Carteret or Pitt counties.

SAURIA

Anolis carolinensis Voigt. Anole.

The three specimens collected are all from Carteret County: two (WMC; 5219) from Shackleford Banks, August 21, and one (5218) from near Beaufort, August 26. Shackleford specimens were taken in a dense bay-yaupon thicket. Anoles were common about the town of Beaufort, and several were seen on Piver's Island.

Cnemidophorus sexlineatus (Linné). Sand swift.

Seven specimens are in the collection: three (3, WMC) from Greene County, July 12, and four (WMC; 5220–22) from Cape Lookout, Core Bank, Carteret County, August 18.

Sand swifts were common under beach drift at Cape Lookout along with *Bufo w. fowleri*. The species apparently occurs commonly on all the North Carolina coastal banks, since Engels (1942) reports it "very common" in similar habitats on Ocracoke Island, and numerous examples were seen on Shackleford Banks.

From our observations *Cnemidophorus* appears to be much less common on the coastal mainland. In the Pitt-Greene County area it has a spotty distribution, colonies being found in isolated sandy areas. The species was observed at two localities, both former sand pits, on the bank of Little Contentnea Creek, located about three miles apart. From the southernmost of these, in Greene County, specimens representing the first records for the county were taken. At the other sand area, in Pitt County, several individuals were seen but eluded capture. Brief visits by the junior author disclosed no *Cnemidophorus* in the extensive sand area on the north bank of the Tar River west of Greenville, Pitt County.

Leiolopisma laterale (Say). Ground skink.

A single specimen (WMC) was taken in Pitt County, July 20.

Eumeces inexpectatus Taylor. Floridan five-lined skink.

One specimen (5217) taken near Newport, Carteret County, August 6, proves to be of this species. It was found under the bark of a charred log in open pine woods.

A number of specimens of *E. inexpectatus* are known from the coastal area of North Carolina, including one from New Bern, Craven County, examined by Taylor in describing the species (Taylor, 1932).

Eumeces fasciatus (Linné) Blue-tailed skink.

A single example (WMC) was collected July 12 in Beaver Dam Swamp, one mile east of Bellarthur, Pitt County.

SERPENTES

Farancia abacura abacura (Holbrook). Mud snake.

The single specimen (WMC), a male 1380 mm. in total length, was taken by the junior author from a drainage ditch in a large pine woods area in Pitt County. It is the first recorded for the county.

Rhadinaea flavilata (Cope). Yellow-lipped snake.

One specimen (5223) was secured August 21, two miles southeast of the northwest end of Shackleford Banks, which thus becomes the third reported locality for the species in North Carolina. It is of interest that two of the three known North Carolina specimens are from the offshore banks. The type was collected on Bogue Bank by Yarrow in November, 1871, "... some eight miles south [?] of Ft. Macon" (Coues and Yarrow, 1878). The present locality is some twelve miles east by slightly south of the type locality, assuming that Yarrow meant eight miles west or southwest of Ft. Macon. Since the trend of Bogue Bank is generally east-west and its width hardly anywhere exceeds a mile, eight miles *south* of Ft. Macon is an improbable locality. The other specimen for the state is from Councils, Bladen County (Schmidt, 1916).

In view of the reported usual association of the species with moist or marshy habitats it may be well to record that this specimen was found under scanty leaf litter in a quite xeric, open, live-oak woods only a few yards from the foot of a moving dune. No shrub or herb growth was present, and there was no marshy ground within several hundred yards. *Microhyla carolinensis* and *Anolis carolinensis*, both mentioned as possible prey-species of *R. flavilata*, were taken in the immediate vicinity.

In color and scutellation our specimen agrees in detail with the description given by Malnate (1939), except that the labials are more densely flecked with brown. The indistinct median dorsal stripe he mentions is evident on the anterior half of the body.

The specimen is a female 263 mm. in total length with a tail length of 83 mm. It has 127 ventrals and 68 caudals. The infralabials are 9-9; the supralabials 7-7.

Coluber constrictor constrictor (Linné). Black snake.

A single example (WMC) was secured in Pitt County, July 10. In addition cast skins of this species were found on Shackleford Banks, August 21; and two DOR's were seen near Cherry Point, Craven County, September 3.

Elaphe obsoleta obsoleta Say. Pilot black snake.

This species is represented in the collection by one specimen (WMC), a female 1703 mm. in total length taken ten miles west of Greenville, Pitt County, on August 6. It is uniformly dark above with no evidence of a blotched or striped pattern. Mid-body scale rows number 27.

We refer the present specimen to *E. o. obsoleta*, since it shows no evidence of variation toward the pattern of *E. o. quadrivittata*. The junior author has found black chicken snakes to be conspicuous and common in the Pitt County area, but has never observed the striped form there. Brimley (1941) records *E. o. obsoleta* as absent south of Wake and Bertie counties, and (1942) reports *E. o. quadrivittata* from Pitt and adjacent Beaufort counties, these localities marking the northern limit of its recorded range. Brimley (*ibid.*) also records apparent *obsoleta-quadrivittata* intergrades from Wake, Johnston, and Cumberland counties in the upper North Carolina coastal plain. Neill (1949a) in his discussion of the *Elaphe obsoleta* group mentions another such intergradient specimen from Columbus County in extreme southeastern North Carolina. He also considers the specimen from Shackleford Banks, Carteret County, which afforded the basis for *E. quadrivittata parallela* (Barbour and Engels, 1942) to be an *obsoleta-quadrivittata* intergrade. From these records it seems rather evident that the populations of *Elaphe obsoleta* occupying the North Carolina coastal plain south from Wake and Pitt counties are a genetically mixed assemblage in which individuals of typical *quadrivittata* pattern occur along with those bearing patterns which tend more or less strongly toward that of *obsoleta*. In the Pitt County area, and presumably all of the coastal plain north of this, the *obsoleta* pattern is found almost exclusively. Specimens from more localities are needed before the area of intergradation can be accurately located and the nature of the cline from *E. o. obsoleta* to *E. o. quadrivittata* discerned.

Lampropeltis calligaster rhombomaculata (Holbrook). Mole snake.

Two specimens (WMC; 5179) were collected west of Greenville, Pitt County, on August 10. Both were taken along country roads bordering upland pine woods. The junior author saw several additional specimens which were plowed up in fields near Greenville, April 1949. The species is not previously reported from Pitt County, but it is probably of frequent occurrence in the coastal area, since Brimley's (1925) records show it to be fairly common at Raleigh.

The specimens fall well within the range outlined by Blanchard (1921) in all characters of pattern and scalation. No. 5179, a male, 855 mm. in total length,

is somewhat unusual in showing complete retention of a well-defined pattern in a large adult. The dorsal body pattern itself is typical, consisting of 40 (snout-vent) convex, bright reddish-brown blotches on a light brown ground color.

We have here given *rhombomaculata* subspecific rank under *Lampropeltis calligaster* in accord with evidence of intergradation of *calligaster* and *rhombomaculata* in northeastern Mississippi, presented by Cook (1945). It should be noted that Blanchard fully anticipated this intergradation in his discussion of the affinities of *rhombomaculata* (*op. cit.*, pp. 131–134).

Lampropeltis getulus getulus (Linné). Common king snake.

The single specimen in the collection (WMC) was taken in Pitt County, August 2. The junior author has found the species to be common in this area.

Natrix erythrogaster erythrogaster (Forster). Red-bellied water snake.

This species is represented by one specimen (WMC) taken from a small spring-fed stream near the Tar River, ten miles northwest of Greenville, Pitt County, July 14. The species appears to be restricted to the coastal plain in North Carolina. Brimley (1942) gives no records from west of Wake County, where it is rare. Our specimen, a male 515 mm. in total length, is the first from Pitt County. It shows a lateral series of obscure, squarish, dark markings, which must represent a partial retention of the juvenile pattern. The belly is without markings.

Natrix sipedon fasciata (Linné). Southern banded water snake.

Four specimens were taken from canals and swamp streams in the Neuse River drainage ten miles west of Greenville, Pitt County: one (WMC, a male with 131 ventrals) on July 10; two (5176, a female with 136 ventrals, and 5177, a female with 130 ventrals) on August 28; and one (WMC, a female with 136 ventrals) on June 5, 1949. They represent the first records for the county, but the species is abundant there in all aquatic habitats except the large rivers.

Brimley (1942) records *N. s. fasciata* from Bertie, Craven, and New Hanover counties on the coast, but expresses doubt concerning the extent of the range of this form in eastern North Carolina. This, coupled with the fact that published range maps for the subspecies of *Natrix sipedon* (Schmidt and Davis, 1941, p. 221) show our Pitt County locality to be near the region where the ranges of *N. s. sipedon* and *N. s. fasciata* meet, makes it advisable to describe the color and pattern of the specimens in detail.

The dorsal pattern of all our specimens consists of transverse bands. One of the specimens (WMC, July 10, 1948) is so dark that the pattern cannot be satisfactorily studied. On two other specimens (5177; WMC, June 5, 1949), also dark, the bands number 28 and 31 respectively. No. 5176 was shedding at the time of capture, and shows the dorsal pattern and color distinctly. The dorsal ground color is light grey, becoming paler on the lower three or four dorsal scale rows. The pattern consists of 32 crossbands which are black dorsally, and orange-red broadly edged with black on the sides. The bands are continued onto

the lateral quarter of the ventrals, and are evident (in 5176) to the tip of the tail. Dorsally the bands are much expanded into quadrate or rhombic blotches four or five scale lengths wide at middorsum, and separated by less than one scale length or in some cases are confluent. Laterally the bands are much narrower, averaging two scale lengths wide, with interspaces of three scale lengths.

The ventral ground color in all specimens is light yellow, becoming grey on the subcaudals. The markings on the ventrals, other than the continuations of the crossbands, are black, or red margined with black. They are predominantly rectangular, especially on the caudals and posterior ventrals. Anteriorly the blotches tend to become irregular in shape, and are occasionally semilunar (as in *N. s. sipedon* and *N. s. pleuralis*). Many of the ventral plates on all specimens show narrow black anterior margins.

The character combination of the dorsal body pattern of complete transverse bands, predominantly squarish ventral markings, and 130 or more ventral plates is diagnostic of *N. s. fasciata* as defined by Clay (1938). The Neuse River drainage in the Pitt County area, therefore, appears to be occupied by populations of the common water snake, which are entirely typical of *N. s. fasciata* with no evidence of variation toward the characters of *N. s. sipedon*.

Natrix sipedon engelsi Barbour. Engels' water snake.

A single specimen of water snake (Duke University Museum), a female 830 mm. in total length, was collected by the junior author June 19, 1949, at Mullet Pond, Shackleford Banks, Carteret County. This is the type locality of the subspecies described by Barbour (1943) under the above name. Barbour's description, drawn from a single specimen, is brief, not adequately differentiating *N. s. engelsi* from other races of *Natrix sipedon*, and no further references to this subspecies have appeared. In the most recent complete treatment of United States snakes (Perkins, 1949) *N. s. engelsi* is not recognized.

Collection of the present topotypic specimen prompted us to attempt a clarification of the nature and status of the variation to which the name *N. s. engelsi* had been applied. The specimen was compared in pertinent characters of pattern and scutellation with our series of *N. s. fasciata* from the Pitt County area of the coastal plain, and with Clay's (1938) accounts of *N. s. fasciata* and *N. s. sipedon*, the forms geographically nearest the presumed range of *N. s. engelsi*. In addition, Mr. Arthur Loveridge of the Museum of Comparative Zoology, Harvard, has kindly checked the characteristics of the type specimen (MCZ 46688), and through the courtesy of Dr. W. L. Engels we have been permitted to examine three water snakes from his collection (W. L. Engels 944, 1085, and 1086) taken on Core Bank, Carteret County, and Ocracoke Island, Hyde County. The included table, and following brief descriptions of patterns summarize the data acquired.

Natrix s. engelsi—Dorsal pattern usually obscure, the black dorsal areas confluent or with narrow (less than one scale length wide) light interspaces. Arrangement of dorsal and lateral blotches various: of complete transverse bands throughout (Shackleford Banks); or with four to nine complete transverse bands

anteriorly, posterior to which the dorsal and lateral series of blotches alternate (Core Bank and Ocracoke Island). Lateral blotches two to three times as wide as the interspaces separating them. Posterior two-thirds to one-half of ventral plates almost entirely black with small irregular light blotches. Anterior ventrals lighter with irregularly arranged sub-quadrate red-centered dark markings.

TABLE 1

SPECIMEN	SEX	LOCALITY	NUMBER OF VENTRALS	NUMBER OF LATERAL BARS (SNOUT-VENT)
		Natrix sipedon engelsi		
MCZ-46688	♂	Mullet Pond, Shackleford Banks, Carteret Co., N. C.	133	35
Duke Univ. Museum	♀	Mullet Pond, Shackleford Banks, Carteret Co., N. C.	138	36
WLE-994	♀	Cape Lookout, Core Bank, Carteret Co., N. C.	144	37
WLE-1085	♂	Ocracoke Island, Hyde Co., N. C.	142	39
WLE-1086	♂	Ocracoke Island, Hyde Co., N. C.	141	32
		Average.....	139	36
		Natrix sipedon sipedon		
		Ranges and averages given by Clay (1938)	135–155	Usually more than 30
		Natrix sipedon fasciata		
		Ranges and averages given by Clay (1938)	126–137	19–33 Ave. 24
5176	♀	10 miles west of Greenville, Pitt Co., N. C.	136	32
5177	♀	10 miles west of Greenville, Pitt Co., N. C.	130	28
WMC-July 10, 1948.	♂	10 miles west of Greenville, Pitt Co., N. C.	131	—
WMC-June 5, 1949.	♀	10 miles west of Greenville, Pitt Co., N. C.	136	31
		Average.....	133	30

Natrix s. sipedon—Three to ten anterior transverse bands, posterior to which the dorsal and lateral series of dark blotches alternate. Lateral blotches equal to or slightly wider than the interspaces separating them. Ventral pattern of crescentic red or dark markings, darker posteriorly.

Natrix s. fasciata—Dorsal and lateral pattern of transverse dark bands throughout. Bands laterally equal to or slightly narrower than the interspaces separating them. Ventral pattern of scattered sub-quadrate red or red-centered dark markings.

The above data show that in characteristics of dorsal pattern and in number of ventral plates specimens of water snakes from the North Carolina offshore

banks exhibit an intermediate condition such as might be expected of samples from a series of intergradient populations between *N. s. sipedon* and *N. s. fasciata*. Specimens from Shackleford Banks have a banded pattern and ventral counts within the range for *N. s. fasciata*, whereas those from Core Bank and Ocracoke Island have a dorsal pattern arrangement similar to that of *N. s. sipedon* and the higher ventral counts of that subspecies. However, in conjunction with the above apparently intergrading characters the "banks" water snakes possess other constant characters in which they differ from both *N. s. sipedon* and *N. s. fasciata*. They are immediately distinguishable from most specimens of both the above subspecies by their general blackish appearance. All specimens seen differ diagnostically in the following characters: 1) venter very heavily pigmented, posterior one-half to two-thirds of ventral plates almost entirely black with small scattered light blotches; and 2) lateral blotches two to three times as wide as the interspaces separating them, the interspaces often less than one scale length in width.

It seems that this puzzling problem is best resolved by considering the populations of the common water snake which occupy the North Carolina offshore banks to represent a distinct dark subspecies, to which the name *Natrix sipedon engelsi* Barbour should be applied. We regard this decision as tentative. Final solution of the problem must await the collection of adequate samples of water snakes from a number of localities both on the "banks" and the coastal mainland. At present we consider it most likely that *N. s. engelsi* will be found to represent another brackish water specialization of the species *Natrix sipedon*, which has already been proved prolific in the development of races adapted to inhabit brackish water environments. *N. s. clarkii* occupies such habitats along the Gulf of Mexico from the central Texas coast to west Florida, and *N. s. compressicauda* occurs along the coasts of peninsular Florida and has in addition extended its range to the northern coast of Cuba.

It seems likely that *N. s. engelsi* will be found to intergrade with *N. s. sipedon* northward along the offshore banks. Intergradation with *N. s. fasciata* is to be expected along the inland limits of salt marsh-brackish water habitats. Although conjecture in the present absence of information is rather fruitless, it is possible that the range of *N. s. engelsi* may also involve a narrow coastal strip along the Atlantic south from Shackleford Banks.

Natrix taxispilota (Holbrook). Brown water snake.

A single specimen (WMC) was collected along the south bank of the Tar River ten miles northwest of Greenville, Pitt County, on July 14.

The species is apparently restricted to swamps along the larger streams, and is rather common in such situations. It is reported by Brimley (1942) from eight counties in the coastal plain, but not previously from Pitt County.

The specimen, a male, is entirely typical, having 30 scale rows at mid-body, supralabials 10-10, and infralabials 12-12. The dorsal pattern consists of 27 square dark blotches (snout-vent), with a similar alternating series on each side.

Storeria occipitomaculata occipitomaculata (Storer). Red-bellied snake.

One specimen (WMC) found ten miles west of Greenville, Pitt County, July 15, is the first on record for the county. It was found under a wood pile several hundred yards from the edge of a tract of pine forest.

Thamnophis sirtalis sirtalis (Linné) Klauber. Ribbon snake.

One specimen (WMC) was collected ten miles west of Greenville, Pitt County, August 6. It represents a "first record" for the county, although the junior author has found the species to be common except in excessively dry years.

The above citation of authority follows the suggestion of Smith (1950). It appears to offer the simplest means of avoiding confusion in the use of the name *T. sirtalis* in reference to the ribbon snake, which is necessitated by Klauber's (1948) demonstration that the Linnean name *T. sirtalis* has previously been misapplied to the common garter snake (now *T. ordinatus*).

Thamnophis ordinatus ordinatus (Linné). Common garter snake.

Our only specimen (WMC) was taken in Pitt County on July 15. It is a female, 648 mm. in total length, which shows an unusual aberration of the color pattern. The characteristic dorsal and lateral stripes of the species are absent, and are replaced by a pattern of numerous sub-rectangular black spots (usually involving parts of three or four scales) on a dark brown ground color. The spots exhibit no regular arrangement. The pattern of the venter is normal.

Agkistrodon contortrix mokeson (Daudin). Northern copperhead.

Two specimens (WMC; 5178) were taken July 7, ten miles west of Greenville, Pitt County. They were found close together at the edge of a cypress swamp adjoining open fields. Copperheads appear to be common in the vicinity, since many others were reported during our collecting.

Gloyd and Conant (1943) refer copperheads from eastern North Carolina to *austrinus* (= *contortrix*), extending the range of this form up the coast to southeastern Maryland. They mention, however, (*op. cit.*, p. 156) the need for examination of additional material from the North Carolina coastal area. The principal diagnostic character used to separate *contortrix* and *mokeson* is the amount of constriction of the cross bands at the dorsal mid-line. In *contortrix* the bands are narrower, averaging less than three scale lengths wide, and many of them incomplete, whereas *mokeson* has fewer incomplete bands with the complete bands averaging over three scale lengths in width. In order better to allocate our specimens, their band characteristics were compared with specimens of *mokeson* from western Maryland, and western Virginia; and with *contortrix* from eastern Texas. The results are presented in table 2.

These data indicate that the Pitt County specimens are practically identical with more northern *mokeson* in the diagnostic character of band width. For this reason we have referred our specimens to *mokeson* despite the fact that they fall within the geographic range of *contortrix* as stated by Gloyd and Conant.

Due to the fact that McCauley (1945) has reported the presence of copperheads resembling *contortrix* in southeastern Maryland, it seems probable that we are here dealing with intergrading populations which occupy a broad zone in the coastal plain of southeastern Maryland, Virginia, and North Carolina.

Agkistrodon piscivorus piscivorus (Lacépède). Water moccasin.

One specimen (WMC) was collected two miles northwest of Grimesland, Pitt County, September 5, in a cypress swamp along Chicod Creek. It is a large dark male measuring 1275 mm. in total length, and is the first reported from the county.

Although this was the only specimen encountered, the species is well-known locally by the name "water rattler." It is said to be abundant in the swamps, and reportedly also occurs along smaller streams into the uplands.

TABLE 2

LOCALITY	SPECIMEN NUMBER	NUMBER OF COMPLETE BANDS	NUMBER OF INCOMPLETE BANDS	AVERAGE BAND WIDTH IN DORSAL MID-LINE*
Pitt Co., North Carolina	WMC	13	2	3.2
Pitt Co., North Carolina	5178	11	1	3.3
Alleghany Co., Virginia	WMC	15	1	3.2
Frederick Co., Maryland	2935	15	2	3.2
Hardin Co., Texas	1204	12	1	1.8

* In calculating average band widths the total number of scale widths of all bands combined was divided by total number of bands (snout-vent), including incomplete bands.

Sistrurus miliarius miliarius (Linné). Ground rattlesnake.

The single specimen (Duke University Museum) was collected by the junior author one mile east of Leechville, Hyde County, October 17. It is a female 314 mm. in total length.

Crotalus horridus atricaudatus Latreille. Canebrake rattlesnake.

The present specimen (WMC), representing the first Pitt County record, was collected by the junior author July 4, 1949, on a road through a large tract of pine forest. It is a female 1235 mm. in total length with 178 ventrals, 22 caudals, and 23 scale rows at midbody. The rattles are unusually intact for a wild-caught specimen, the string numbering 13 rattles and measuring 75 mm. in length.

The specimen is referred to *C. h. atricaudatus* despite its having only 23 dorsal scale rows because the color pattern is entirely characteristic of that form: anterior lateral blotches with light centers; distinct postocular dark stripe; and red brown mid-dorsal stripe distinct for the entire length of the body.

TESTUDINATA

Kinosternon subrubrum subrubrum (Lacépède). Common mud turtle.

Two specimens are at hand: one (WMC) collected at Little Contentnea Creek, ten miles west of Greenville, July 9; the other (5172) from Chicod Creek Swamp

near Grimesland, Pitt County, September 5. These are the first recorded from Pitt County. The first of these is typical *K. s. subrubrum*. No. 5172, a female with a carapace length of 117 mm., clearly shows the light striping on the sides of the head, which elsewhere characterizes *K. s. hippocrepis*. Another similarly marked specimen from the same locality has since been lost. Comparison of 5172 with 15 specimens of *K. s. hippocrepis* in UINHM from Louisiana, Arkansas, eastern Texas, and southeastern Oklahoma shows no difference in the head striping, except that some of the western specimens (all considerably smaller, the largest with carapace 95 mm. in length) have the stripes slightly broader, and more clearly defined.

The stated range of *K. s. hippocrepis* extends eastward only to southern Alabama, and intergradation with *K. s. subrubrum* presumably occurs on the Gulf coastal plain in southern Mississippi and Alabama, and perhaps extreme western Florida (Carr, 1940, p. 98). Due to the wide separation between these points and the North Carolina locality it seems requisite to consider the specimens mentioned as representing a local color pattern anomaly of *K. s. subrubrum*, at least until the occurrence of this variation becomes more fully known.

Chelydra serpentina serpentina Linné. Common snapping turtle.

The snapping turtle was found to be common in all streams in the Pitt County area where any collecting was done. Two specimens taken July 7 from Little Contentnea Creek were later discarded.

Clemmys guttata (Schneider). Spotted turtle.

Our single specimen (WMC) was collected from Little Contentnea Creek, ten miles west of Greenville, Pitt County, June 19.

Terrapene carolina carolina (Linné). Box turtle.

Three specimens were collected ten miles west of Greenville, Pitt County: two (WMC) on July 1, and one (5175) on September 4. The species was found to be common in upland habitats in Pitt County, particularly in overgrown fields. Another specimen (subsequently lost) was collected in pine woods five miles north of Beaufort, Carteret County, on August 7.

Malaclemys terrapin centrata (Latreille). Diamond back terrapin.

One specimen (5173) was taken July 28 from the trawl of a shrimp boat in the Newport River, above Beaufort, Carteret County. It is listed under the present subspecies solely on the basis of range, as the subspecific characters are not strongly shown.

Chrysemys picta picta (Schneider). Painted turtle.

Two specimens were collected in cypress-gum swamps in Pitt County: one (5174) along Chicod Creek, two miles northwest of Grimesland, September 5; and the other (WMC) from Little Contentnea Creek, ten miles west of Greenville on July 11. They are the first recorded for the county.

BIBLIOGRAPHY

BAKER, C. L. 1947. The species of amphiumae. Jour. Tenn. Acad. Sci. **22:** No. 1: 9–21.

BARBOUR, THOMAS. 1943. A new water snake from North Carolina. Proc. New England Zool. Club **22:** 1–2, plate 1.

——— AND WILLIAM L. ENGELS. 1942. Two interesting new snakes. Proc. New England Zool. Club **20:** 101–104, plates 16–17.

BISHOP, SHERMAN C. 1941. The salamanders of New York. New York St. Mus. Bull., No. 324: 3–365.

——— 1943. Handbook of salamanders. Comstock Pub. Co., Inc., Ithaca, N. Y., xiv + 555 pp.

BLANCHARD, FRANK N. 1920. A synopsis of the king snakes: genus *Lampropeltis*. Occ. Papers Mus. Zool. Univ. Mich., No. 87: 1–7, 1 table.

——— 1921. A revision of the king snakes: genus *Lampropeltis*. Bull. U. S. Natl. Mus., No. 114: 1–260.

BRADY, MAURICE. 1927. Notes on the reptiles and amphibians of the Dismal Swamp. Copeia, No. 162: 26–29.

BRANDT, B. B. 1936. The frogs and toads of eastern North Carolina. Copeia, No. 4: 215–223.

BRIMLEY, C. S. 1907. Keys to North Carolina snakes, lizards, and batrachians. Jour. Elisha Mitchell Sci. Soc. **23:** 141–160.

——— 1909. Some notes on the zoology of Lake Ellis, Craven County, North Carolina, with special reference to herpetology. Proc. Biol. Soc. Wash. **22:** 129–138.

——— 1925. The seasonal catch of snakes at Raleigh, N. C. Jour. Elisha Mitchell Sci. Soc. **41:** 100–103.

——— 1926. Revised key and list of the amphibians and reptiles of North Carolina. Jour. Elisha Mitchell Sci. Soc. **42:** 75–93.

——— 1939–1943. The amphibians and reptiles of North Carolina. Carolina Tips, Vols. 2 to 6.

CAMPBELL, GEORGE R., AND WILLIAM H. STICKEL. 1939. Notes on the yellow-lipped snake. Copeia, No. 2: 105.

CARR, ARCHIE F., JR. 1940. A contribution to the herpetology of Florida. Univ. Fla. Publ., Biol. Ser., Vol. III, No. 1: 1–118.

CLAY, WILLIAM M. 1938. A synopsis of the North American water snakes of the genus *Natrix*. Copeia, No. 4: 173–182.

CONANT, ROGER. 1949. Two new races of *Natrix erythrogaster*. Copeia, No. 1: 1–15.

COOK, FANNYE A. 1945. Intergradation of *Lampropeltis calligaster* and *L. rhombomaculata* in Mississippi. Copeia, No. 1: 47–48.

COUES, ELLIOTT. 1871. Notes on the natural history of Fort Macon, N. C., and vicinity. (No. 1.) Proc. Acad. Nat. Sci. Phila. **1871:** 12–49.

———, and H. C. YARROW. 1878. Notes on the natural history of Ft. Macon, N. C., and vicinity. (No. 4.) Proc. Acad. Nat. Sci. Phila. **1878:** 21–28.

DUNN, E. R. 1926. The salamanders of the family Plethodontidae. Smith College 50th Ann. Publ., Northampton, Mass., vii + 441 pp.

——— 1938. Notes on frogs of the genus *Acris*. Proc. Acad. Nat. Sci. Phila. **90:** 153–154.

ENGELS, W. L. 1942. Vertebrate fauna of North Carolina coastal islands: A study in the dynamics of animal distribution. 1. Ocracoke Island. Amer. Midl. Nat. **28:** 273–304.

GLOYD, HOWARD K. 1940. The rattlesnakes, genera *Sistrurus* and *Crotalus*. Spec. Publ. No. 4, Chicago Acad. Sci., vii + 266 pp.

———, AND ROGER CONANT. 1943. A synopsis of the American forms of *Agkistrodon* (copperheads and moccasins). Bull. Chicago Acad. Sci. **7:** No. 2: 147–170.

GRAY, I. E. 1941. Reptiles and amphibians of the Duke Forest. Amer. Midl. Nat. **27:** 652–658.

HECHT, MAX K., AND BESSIE L. MATALAS. 1946. A review of middle North American toads of the genus *Microhyla*. Amer. Mus. Novitates, No. 1315: 1–21.

KLAUBER, L. M. 1948. Some misapplications of the Linnaean names applied to American snakes. Copeia, No. 1: 1–14.

LODING, H. P. 1922. A preliminary catalogue of Alabama amphibians and reptiles. Ala. Mus. Nat. Hist. Paper No. 5: 7–59.

MCCAULEY, ROBERT H. 1945. The reptiles of Maryland and the District of Columbia. Publ. by the author, Hagerstown, Md. 194 pp.

MALNATE, EDMOND. 1939. A study of the yellow-lipped snake, *Rhadinaea flavilata* (Cope). Zoologica **24**: 359–366.

MITTLEMAN, M. B. 1944. The status of *Testudo terrapin* Schoepf. Copeia, No. 4: 245–250.

——— 1945. Additional notes on the name *Testudo terrapin* Schoepf. Copeia, No. 4: 233–234.

——— 1947. American caudata. 1. Geographic variation in *Manculus quadridigitatus*. Herpetologica **3**: 209–224.

MYERS, G. S. 1924. Amphibians and reptiles from Wilmington, N. C. Copeia, **131**: 59–62.

NEILL, WILFRED T. 1946. Notes on banded water snakes from Georgia. Copeia, No. 4: 255–256.

——— 1949. A series of *Manculus* from Georgia. Herpetologica **5**: 29–30.

——— 1949a. A new subspecies of rat snake (genus *Elaphe*), and notes on related forms. Herpetologica **5**: Suppl. 2: 1–12, 1 map.

———, AND FRANCIS L. ROSE. 1949. Nest and eggs of the southern dusky salamander, *Desmognathus fuscus auriculatus*. Copeia, No. 3: 234.

NETTING, M. GRAHAM. 1936. *Rhadinaea flavilata* (Cope) in Texas. Copeia, No. 2: 114.

———, AND COLEMAN J. GOIN. 1945. The cricket-frog of peninsular Florida. Quart. Jour. Fla. Acad. Sci. **8**: No. 4: 304–310.

NOBLE, G. K., AND L. B. RICHARDS. 1932. Experiments on the egg-laying of salamanders. Amer. Mus. Novitates, No. 513: 1–25.

———, AND GERTRUDE EVANS. 1932. Observations and experiments on the life history of the salamander *Desmognathus fuscus fuscus* (Rafinesque). Amer. Mus. Novitates, No. 533: 1–16.

PERKINS, C. B. 1949. A key to the snakes of the United States. Second edition. Bull. Zool. Soc. of San Diego, No. 24: 5–79.

POPE, CLIFFORD H. 1939. Turtles of the United States and Canada. Alfred A. Knopf, New York, xviii + 343 pp.

SCHMIDT, KARL P. 1916. Notes on the herpetology of North Carolina. Jour. Elisha Mitchell Sci. Soc. **32**: 33–37.

———, AND D. DWIGHT DAVIS. 1941. Field book of snakes of the United States and Canada. G. P. Putnam's Sons, New York. xiii + 365 pp.

SMITH, HOBART M. 1946. Handbook of lizards. Comstock Publ. Co., Inc., Ithaca, N. Y., xxi + 557 pp.

——— 1950. Milestones in herpetology, 1948. Part III. Turtox News **28** (1): 14–16.

STEJNEGER, LEONHARD, AND THOMAS BARBOUR. 1943. A check-list of North American amphibians and reptiles. 5th ed., Harvard Univ. Press, Cambridge, xx + 260 pp.

TAYLOR, EDWARD H. 1932. *Eumeces inexpectatus*: a new American lizard of the family *Scincidae*. Univ. Kans. Sci. Bull. **20**: No. 13: 251–261.

WELLS, B. W. 1928. Plants communities of the coastal plain of North Carolina, and their successional relations. Ecology **9**: 230–242.

WRIGHT, A. H., AND A. A. WRIGHT. 1949. Handbook of frogs and toads of the United States and Canada. 3rd ed. Comstock Publ. Co., Inc., Ithaca, N. Y., xii + 640 pp.

A NEW SPECIES OF DIAPTOMID COPEPOD FROM MANITOBA*

By I. Gilbert Arnason

Central Fisheries Research Station, Fisheries Research Board of Canada

Winnipeg, Manitoba

Twenty-three Text Figures

Diaptomus manitobensis n. sp.

Large stout species. Female 2.4 mm. exclusive of furcal setae, male 2.6 mm. Metasome plump with first segment longer than three following, strongly convex in dorsal profile especially in mid region and at anterior end; posterolateral projections fairly large reaching to spines of genital segment; projections directed obliquely posteriorly and laterally each tapering to sharp hyaline points tipped by tiny spines; a second larger point and spine on dorsal margin.

First segment of female abdomen longer than rest of abdomen; much dilated in front and somewhat laterally with two small lateral spines. Second segment very short. Furca about the same length as the second segment. Furcal rami ciliate on inner margins of distal third.

Antennae 25-segmented, slender and relatively long, reaching to middle of abdomen. Small setae unmodified (Fig. 3); three setae on segment 2 and segment 16, two each on segments 6, 9–11, 13–15, 17, 18, 22–24, one each on all others save segment 25 which has five. Major spines on segments 10, 11, and 13 of right antenna of male (Fig. 3); major spines slightly to considerably incurved; spine of segment 10 about the same length as width of antenna, that of segment 11 slightly longer, and that on segment 13 at least twice as long as that on segment 10, incurved and bluntly hornlike in appearance. Segments 13–17 of male right antenna markedly swollen, segment 18 somewhat less so; lateral hyaline membrane on antepenultimate segment slender and terminating in a short delicate incurved hook.

Fifth legs of male narrow, elongated; left leg reaching just past middle of first segment of exopodite of right leg. Spines of basal segments of male fifth feet short, stout and blunt. Second basal segment of right foot quadrangular, about two and one-half times as long as wide; near the proximal end a dome-shaped hyaline projection confluent with a lateral hyaline lamella extending most of its length along the inner surface and terminating distally in a broad hyaline hook-shaped process. The first segment of exopodite of right leg about four-fifths as wide and about two-thirds as long as the second basal segment. Second segment of exopodite slender, widening somewhat about seven-eighths from the proximal end, and then narrowing sharply in the distal eighth; about one and one-half times as long as the first exopodite or about the same length as the second basal segment (basipodite). Lateral spine, narrow and straight, about

* Submitted as part of a thesis for the degree of Doctor of Philosophy, University of Manitoba.

one-third longer than segment is wide, arising from distal lateral angle, continuing almost in line with lateral margin of segment; claw (Fig. 2) over two-thirds as long as second segment of exopodite, slender, smooth, somewhat swollen in proximal portion, curved symmetrically inward in the middle region and outward at the pointed tip. The endopodite slender, one-segmented, extending about seven-eighths of the length of the first segment of the exopodite, coarsely setose at the distal end. Second basal segment of left leg quadrangular, one and one-half times as broad as first segment of exopodite, with a narrow hyaline ridge running the length of the inner lateral margin; lateral spine short and stout, inserted slightly anterior to distal angle. First segment of exopodite about twice as long as broad, widening distally, its outer margin almost straight, its inner margin curved; inner margin terminating in a rounded or dome-shaped projection which is finely setose. Second segment of exopodite slender, about four times as long as wide, terminating in two spines, the outer of which is short and smooth and the inner of which is long curved and setose. Endopodite one-segmented, slender, extending slightly beyond the distal end of the first exopodite, crenulated along the inner margin and setose at the tip.

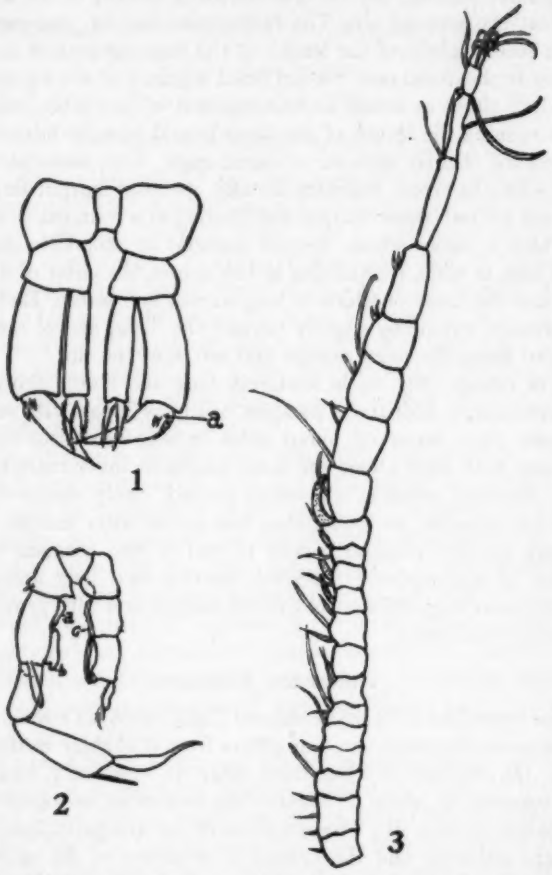
Fifth legs of female (Fig. 1) is relatively long and stout; third segment of exopodite rudimentary, indistinct, its spine nearly as long as its seta; spine on second segment stout, incurved, about twice as long as seta of third segment. Second segment with claw about the same length as inner margin of first segment; claw relatively slender, somewhat curved, finely denticulate on both inner and outer margins, but somewhat less so on outer margin. Endopodite one-segmented, slender, reaching nearly to end of first segment of exopodite; apical portion of endopodites truncated, bearing two long apical setae, the median slightly over four-fifths as long as the lateral, and with proximal spinelets graduating into distal hairs.

TAXONOMIC POSITION

This species resembles *Diaptomus caducus* Light (1938) in size and in the large number of setae on the antennae, but differs from it slightly in the distribution of the setae. (*D. manitobensis* has three setae on segment 2 and segment 16, and one on segment 19, while *D. caducus* has four setae on segment 2, and two each on segments 16 and 19). The armature of the antepenultimate segment of the male right antenna, and the details of structure of the male and female fifth legs, distinguish this species both from *D. caducus* and from the closely related *Diaptomus shoshone* Forbes (1893).

In *D. caducus*, the process on the antepenultimate segment of the male right antenna is longer than the penultimate segment, thicker at the base and usually tapering to a point, rarely with a swollen tip (Fig. 17). In *D. shoshone*, the process on the antepenultimate segment is only slightly longer than the penultimate segment (Fig. 21), thicker at the base, tapering to a point. Both these species lack the lateral hyaline membrane found on the antepenultimate segment of *D. manitobensis*. In both *D. caducus* and *D. shoshone* there is a distinct third segment of the exopodite of the female fifth leg, while the corresponding third

segment of the exopodite in *D. manitobensis* is rudimentary and indistinctly separated from segment 2. In *D. manitobensis* the endopodite of the male fifth leg is one-segmented (in both right and left fifth legs), while in *D. caducus* it is



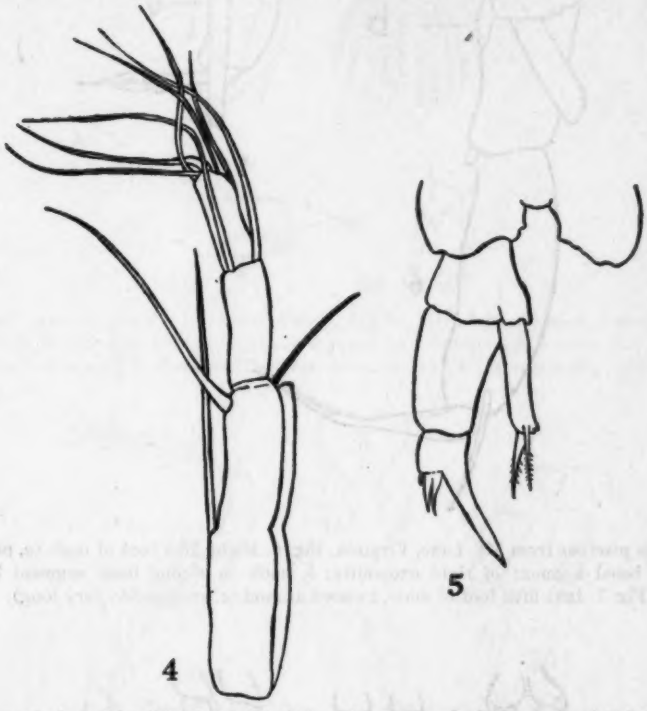
Diaptomus manitobensis n. sp. Fig. 1. Fifth legs of female (*a*, rudimentary third segment of exopodite). × 59. Fig. 2. Fifth legs of male (*a*, process; *b*, hook; *c*, process). × 57. Fig. 3. Right antenna of male. × 59.

two-segmented (Figs. 19, 20). In *D. shoshone* the endopodite of male left fifth leg is two-segmented, while the endopodite of male right fifth leg is one-segmented.

In *D. manitobensis* the absence of the slender apical extensions of the endopods of the fifth legs of the female is noteworthy. This character is a point of resemblance between this species and *Diaptomus leptopus* Forbes, *D. piscinae* Forbes and *D. caducus*, and also a point of distinction from *D. shoshone*.

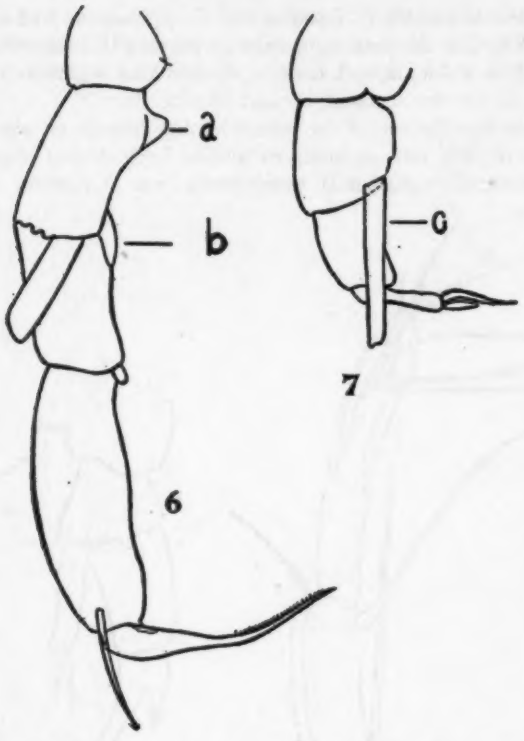
D. manitobensis resembles *D. leptopus* and *D. piscinae* as well as *D. caducus* and *D. shoshone* in that the male right antenna appears to have only 22 segments instead of 25. This is due, in each case, to the fact that segments 19, 20, and 21 are ankylosed, as are also segments 22 and 23 (Fig. 3).

In *D. manitobensis* the end of the lateral hyaline lamella on segments 22 and 23 is projected distally into an incurved hyaline hook-shaped process (Fig. 3.). This characteristic distinguishes *D. manitobensis* from *D. piscinae*. It, moreover,

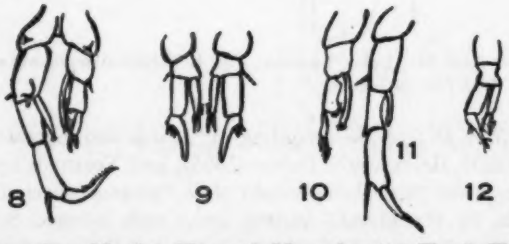


Diaptomus piscinae from Mt. Lake, Virginia. Fig. 4. Terminal segments of right antenna of male. Fig. 5. Fifth foot of female.

distinguishes it from *D. leptopus* according to "Marsh and several other copepod taxonomists" (1893), Herrick and Turner (1895), and Yeatman (correspondence with the author, 1949). Also the specimen of *D. leptopus* collected from Singush Lake, Manitoba, by the present author, lacks such a hook. Schacht (1897), however, in his description of *D. leptopus*, states that the segments 22 and 23 of the male right antenna have ". . . a narrow hyaline lamella produced into a hook which extends but a little beyond the end of the segment." Also S. A. Forbes (1882), in his original description of *D. leptopus* states: "The antennae reach to the tip of the furca, and the antepenultimate segment of the right antenna bears a small hook at the tip in the male." Forbes shows no antennal figure, and

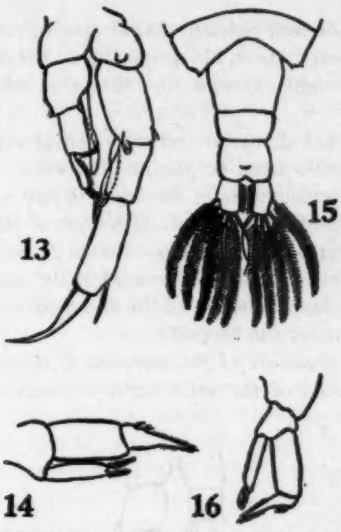


Diaptomus piscinae from Mt. Lake, Virginia. Fig. 6. Right fifth foot of male (*a*, process on second basal segment of right exopodite; *b*, hook on second basal segment long and large). Fig. 7. Left fifth foot of male, twisted around (*c*, endopodite very long).

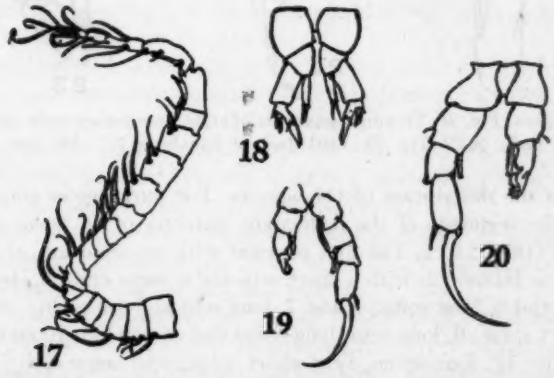


Diaptomus leptopus from Marthas Vineyard, Massachusetts. Fig. 8. Fifth legs of male. Fig. 9. Fifth legs of female. (Both after Wilson, 1932)

Diaptomus leptopus from Woods Hole, Massachusetts. Fig. 10. Left fifth leg of male. Fig. 11. Right fifth leg of male. Fig. 12. Left fifth leg of female. All × 44. (After Forbes, 1882)



Diaptomus piscinae. Fig. 13. Fifth feet of male. Fig. 14. Fifth foot of female, Portage Slough specimen. × 140. Fig. 15. Last thoracic segment and abdomen of female. × 70. Fig. 16. Fifth foot of female, Yellowstone Park specimen. × 140. (All after Schacht, 1897)



Diaptomus caducus. Fig. 17. Right antennule of male. × 34. Fig. 18. Fifth legs of female. × 42. Fig. 19. Fifth legs of male in posterior view. × 34. Fig. 20. Fifth legs of male in anterior view. × 49. (All after Light, 1938)

neither he nor Schacht says whether this hook is incurved or outcurved. Wilson (1932) states concerning the same character of *D. leptopus*: "Right antenna much swollen anterior to the geniculating segment; a narrow hyaline membrane on the antepenultimate segment, prolonged slightly at the distal end into a small *knob*."

It may be that Forbes and Schacht found specimens of *D. leptopus* with a small *knob*, such as Wilson finds on his specimens, at the distal end of the hyaline membrane of the male right antenna, and that this has been inaccurately described as a *hook*.

The following additional characters serve to distinguish *D. manitobensis* from *D. leptopus* Forbes and also from *D. piscinae* Forbes:

1. *The relatively short endopodite of the left fifth foot of the male* found in *D. manitobensis*. The endopodite of the left fifth foot of the male is only slightly longer than the first segment of the exopodite in *D. manitobensis*, while in *D. leptopus* the corresponding endopodite is considerably, and in *D. piscinae* greatly longer. In the latter species the length of the endopodite is equal to that of both first and second segments of the exopodite.

2. *Differences in the armature of the segments of the male right antenna.* The armature of the segments of the male right antenna of *D. manitobensis* has

Diaptomus shoshone. Fig. 21. Terminal segments of right antenna of male. × 120. **Fig. 22.** Fifth feet of male. × 72. Fig. 23. Fifth foot of female. × 72. (All after Marsh, 1907)

been noted in the description of this species. For purposes of comparison the armature of the segments of the male right antenna of *D. leptopus* is quoted from Schacht (1897): "... The first segment without armature, the other segments armed as follows: 2, with a short seta and a sense-club; 3, short seta and sense-club; 4 and 6, long spine; 5 and 7, long seta and sense-club; 8, long spine and very short spine; 9, long seta, long spine and sense-club; 10 and 11, process and long spine; 12, long spine, very short spine, and sense-club; 13, process, long spine and sense-club; 14, long seta, long spine, and sense-club; 15, process, short seta, long spine, and sense-club; 16, process, long spine, long seta, and sense-club; 17, process, and short thick spine; 18, process; 19, 20 and 21 (completely ankylosed), a narrow hyaline lamella produced into a hook which extends but little beyond the end of the segment, and two long setae; 24, two long setae; and 25, four long setae and a sense hair. Some of the setae on the last segment are sparsely hairy." It will be seen that *D. manitobensis* differs in some or all details of the armature of *every* segment of the male right antenna, *excepting only* the ankylosed segments 22 and 23, and segment 24. In these segments, only, is the armature identical.

I have not found a detailed description of the armature of all the segments of the male right antenna of *D. piscinae*. The following is quoted from Forbes (1893): "The right antenna of the male is without notable distinctive characters. The antepenultimate segment is as long as the two following taken together; the fourth from the tip bears two long sword-like spines at its margin, both attached to its basal fourth; the expanded segments are well armed with conical spines, straight and curved, but without hooks." Forbes also states: " . . . This species (*D. piscinae*) differs from *D. leptopus* by its more slender form and by the absence of the antennal hook." The fourth segment from the tip of the male right antenna of *D. manitobensis* bears only a single seta, at its distal end, whereas Forbes' specimens of *D. piscinae* bore two long sword-like spines at the margin, both attached to the basal fourth, on the corresponding segment of the male right antenna. In addition, Marsh, for *D. leptopus* (1907, Pl. XX, Fig. 5) and Carolyn Coker (Fig. 4) for *D. piscinae*, both show a slender hairlike seta at the distal end of the antepenultimate segment, and on the same side as the hyaline lamella. This is not found in *D. manitobensis*. Furthermore, Wilson (1932) shows an illustration (Pl. I, Fig. f.) of a female *D. leptopus* bearing extremely hairy setae. In the female of *D. manitobensis* only a few setae are sparsely hairy, the remainder being naked.

3. Terminal hook of the male right fifth foot *not denticulate* in *D. manitobensis*; *denticulate* in *D. leptopus* and in *D. piscinae*.

4. Second basal segment of left fifth foot of male with a narrow hyaline ridge or process running the length of the inner lateral margin in *D. manitobensis*; not present in *D. leptopus* nor in *D. piscinae*.

5. *D. manitobensis* is somewhat larger than is usual for *D. leptopus* or *D. piscinae*. No great significance is attached to this difference in itself, since factors such as water temperature might influence size.

In conclusion, the author is of the opinion that sufficient evidence has been presented to justify the establishment of the new species *Diaptomus manitobensis*. It appears to be closely related to *D. leptopus* Forbes.

This species was obtained from alimentary canals of young goldeyes, *Amphiodon alosoides* (Rafinesque), collected by Dr. W. M. Sprules from Head River Lake, Manitoba (53° 45′ N. Lat. 100° 35′ W. Long.).

The author wishes to express his thanks to Mr. H. C. Yeatman for kindly reading first and second drafts of this paper, and for helpful suggestions and criticisms. Thanks are also due to Carolyn Coker (former student in hydrobiology at the University of North Carolina) for tracings of drawings of *D. piscinae* from Mt. Lake, Virginia. These are reproduced by permission as Figures 4–7.

LITERATURE CITED

FORBES, S. A. 1882. On some Entomostraca of Lake Michigan and adjacent waters. Amer. Nat. **16**: 537–543; 640–650; figs.

——— 1893. A preliminary report of the aquatic invertebrate fauna of the Yellowstone National Park, Wyoming, and of the Flathead region of Montana. Bull. U. S. Fish. Comm. **1891**: 207–258, pls. 37–42.

HERRICK, C. L., AND C. H. TURNER. 1895. Synopsis of the Entomostraca of Minnesota. Geol. and Nat. Hist. Surv. Minn., Zool. Ser. 2. 525 pp., 81 pls.

LIGHT, S. F. 1938. New subgenera and species of diaptomid copepods from the inland waters of California and Nevada. Univ. of Cal. Publ. in Zool. **43**: No. 3: 67–78, figs. 1–23. University of California Press, Berkeley.

MARSH, C. DWIGHT. 1893. On the Cyclopidae and Calanidae of central Wisconsin. Trans. Wisc. Acad. Sci. Arts and Let. **9**: 189–224, 4 pls.

——— 1907. A revision of the North American species of Diaptomus. Trans. Wisc. Acad. Sci. **15**: 381–516, 14 pls.

SCHACHT, FREDERICK WILLIAM. 1897. The North American species of Diaptomus. (Thesis) Bull. III. Illinois State Lab. Nat. Hist. **5**: art. 3: 97–208, 15 pls.

WILSON, C. B. 1932. The copepods of the Woods Hole region, Massachusetts. Bull. U. S. Nat. Mus. **158**: 1–635, figs.

SOME ESTERS OF THE ISOMERIC NITRO- AND AMINOBENZENESULFONIC ACIDS

By R. W. Bost and George F. Deebel*

The Venable Chemical Laboratory of the University of North Carolina
Chapel Hill, North Carolina

While a few esters of the isomeric nitro- (1), (2), (5) and aminobenzenesulfonic (3), (6) acids have been reported, no systematic study of their preparation and properties has been made. By analogy with the corresponding aminobenzoic acid esters, it seemed desirable to ascertain if these compounds exhibited any local anesthetic activity.

We have prepared eighteen esters, fifteen of them new, of the isomeric nitrobenzenesulfonic acids by the following methods: reaction of the sodium alcoholate with the nitrobenzenesulfonyl chloride, an extension of Demeny's method; reaction of the alcohol with the nitrobenzenesulfonyl chloride in the presence of pyridine, which is an application of the method of Marvel and Sekera (4); and reaction of excess alcohol with the nitrobenzenesulfonyl chloride. All, except four, of these esters were reduced with stannous chloride at low temperatures to the corresponding aminobenzenesulfonic acid esters, which were characterized by the preparation of their hydrochlorides. Since none of the aminobenzenesulfonic acid esters here reported have been prepared previously by this method, our data substantiate the procedures used by other workers (3), (6).

All nitrobenzenesulfonic acid esters prepared were found to be quite stable and resistant to hydrolysis under storage conditions.

The esters of orthanilic and metanilic acids were found to be liquids and to hydrolyze so rapidly that they could not be isolated as the free bases. Their hydrochlorides were prepared and found to be sufficiently stable for analysis.

The esters of sulfanilic acid were all solids, with the exception of the n-butyl compound, and more stable than the ortho and meta isomers. On long standing most sulfanilic acid esters, except those containing a halogenated-alcohol moiety, were found to hydrolyze completely to sulfanilic acid and the alcohol.

The hydrochlorides of all the isomeric aminobenzenesulfonic acid esters, except those containing a halogenated-alcohol moiety, were found to lose all hydrogen chloride and to hydrolyze completely on long standing to form the free aminobenzenesulfonic acid.

In marked contrast to many of the esters of the aminobenzoic acids none of the esters of the aminobenzenesulfonic acids exhibited any local anesthetic activity.

EXPERIMENTAL

Preparation of the esters of the nitrobenzenesulfonic acids

(A) Sodium Alcoholate-Nitrobenzenesulfonyl Chloride Method. This method was found best for the preparation of the esters of unsubstituted and unsaturated

* Present address, Monsanto Chemical Co., Dayton 7, Ohio.

alcohols. Two and three-tenths grams of sodium was dissolved in the alcohol to be esterified. This solution was cooled and added slowly with stirring to 0.1 mole (22.1 g.) of the appropriate nitrobenzenesulfonyl chloride dissolved in 250 cc. of anhydrous ether. The reaction mixture was surrounded with an ice bath. The reaction was complete in about fifteen minutes, after which the ether and excess alcohol were removed by evaporation under an electric fan. The reaction product was washed with water and air dried. The crude ester was dissolved in ether, stirred with Norite and filtered. To the cold, colorless filtrate was added petroleum ether (b. 60–90°), whereupon colorless crystals of the ester were obtained in good yields.

(B) Alcohol-Nitrobenzenesulfonyl Chloride-Pyridine Method. This method was used to prepare esters of the halogenated alkanols. A mixture of 0.55 mole of the halogenated alkanol and 248 g. of pyridine was cooled to 10° with stirring, and 0.5 mole (110 g.) of the appropriate nitrobenzenesulfonyl chloride was added slowly. The temperature was allowed to rise to 20° during the four hours of stirring which followed the complete addition of the acid chloride. The mixture was allowed to stand two hours, then poured into a beaker containing 600 g. of cracked ice, 400 cc. of water and 300 cc. of conc. hydrochloric acid. The oil which separated soon crystallized. It was filtered, washed with ice water and dried. The ester was purified by dissolving in benzene, agitating with Norite, filtering and reprecipitating with petroleum ether (b. 60–90°).

(C) Alcohol-Nitrobenzenesulfonyl Chloride Method. The esters of β-diethylaminoethanol were prepared by this method. Considerable tar formation was encountered when attempts were made to prepare esters of this alcohol by the other mentioned methods. To a solution of 0.1 mole (22.1 g.) of the appropriate nitrobenzenesulfonyl chloride in 250 cc. of anhydrous ether was added slowly, with cooling and stirring, 24 cc. of β-diethylaminoethanol dissolved in 50 cc. of anhydrous ether. The mixture was allowed to stand fourteen hours, during which time a semisolid mass formed and partially crystallized. Decantation of the ether and addition of acetone to the sticky mass resulted in additional crystallization of the ester. The ester was recrystallized from 95% ethanol, by means of which it was separated from the β-diethylaminoethanol hydrochloride. The hydrochlorides of the esters were prepared in the usual manner by passing hydrogen chloride into a methanol solution of the ester and precipitating by the addition of dry ether.

Preparation of the aminobenzenesulfonates

The nitrobenzenesulfonates were reduced to the amino compounds by dissolving or suspending 0.2 mole of each in 300 cc. of glacial acetic acid, adding 0.6 mole of powdered stannous chloride and passing hydrogen chloride into the well-stirred mixture at a temperature below 48°. The temperature control was important to prevent hydrolysis of the ester. The solutions became clear after one or two hours time and were then allowed to stand an equal period before neutralizing below 18° with 25% sodium hydroxide. Temperatures higher than 18° during this latter operation resulted in hydrolysis of the esters. In many

cases the aminobenzenesulfonates precipitated and were filtered off; in others emulsions were formed which necessitated extraction with ether to effect isolation. Purifications were made through the hydrochlorides. Due to the ease of hydrolysis it was necessary to exercise care in controlling temperature and pH when the hydrochloride was converted to the free base. The aqueous solutions of the hydrochlorides were titrated to a pH of 7 below 18° and extracted with ether. These extracts were treated with Norite, filtered and the ester precipitated by the addition of petroleum ether (b. 60–90°). Good yields of pure white compounds resulted. Evaporation of the excess solvents, without heating, gave additional crystals. The compounds were all insoluble in water but soluble in ether and acetone and slightly soluble in ethanol. The allyl and β-diethylaminoethyl derivatives hydrolyzed before they could be isolated.

TABLE I

β-Diethylaminoethyl esters

BENZENE-SULFONATE	METHOD	% YIELD	M.P. °C.	FORMULA	SULFUR, %	
					Calcd.	Found
2-Nitro-	C	20	250	$C_{12}H_{18}O_6N_2S$	10.59	10.50
3-Nitro-	C	20	272	$C_{12}H_{18}O_6N_2S$	10.59	10.53
4-Nitro-	C	20	297	$C_{12}H_{18}O_6N_2S$	10.59	10.57

TABLE II

Hydrochlorides of β-diethylaminoethyl esters

BENZENE-SULFONATE	M.P. °C.	FORMULA	NEUTRAL EQUIVALENT	
			Calcd.	Found
2-Nitro-	Subl. 300	$C_{12}H_{19}O_6N_2ClS$	338.5	341
3-Nitro-	Subl. 320	$C_{12}H_{19}O_6N_2ClS$	338.5	335.5
4-Nitro-	Subl. 326	$C_{12}H_{19}O_6N_2ClS$	338.5	347

Stability of metanilic acid esters

Ethyl metanilate, a brown liquid solidifying at 18–19°, was prepared by method (A). An ether solution was dried over Drierite for fourteen hours and then filtered into a dry flask. The ether was removed under reduced pressure at room temperature by use of a Hyvac pump and then sealed to the atmosphere by means of a stopcock while still under vacuum. Within a few minutes solid material began to form. Two weeks later the flask was opened and the mass triturated with dry ether to remove the unchanged ester. The solid which remained was dissolved in cold absolute ethanol and reprecipitated by the addition of dry ether. The resulting white, water-insoluble compound was diazotized and coupled with β-naphthol to give a dye and fusion with potassium hydroxide converted it into 3-aminophenol.

Anal. Calcd. for $H_2NC_6H_4SO_2OH \cdot C_2H_5OH$: N.E., 219; S, 14.61%; C, 43.83%; H, 5.93%. Found: N.E., 219, 220; S, 14.66%; C, 43.44%; H, 5.33%.

TABLE III

4-Nitrobenzenesulfonates

ESTER	METHOD	% YIELD	M.P. °C.	FORMULA	SULFUR, %	
					Calcd.	Found
Methyl	A	84.3	91.5	$C_7H_7O_5NS$	14.74	14.70
Ethyl	A	54.6	90*	$C_8H_9O_5NS$	13.85	13.92
n-Propyl	A	83.6	72	$C_9H_{11}O_5NS$	13.06	13.22
n-Butyl	A	81.1	61	$C_{10}H_{13}O_5NS$	12.35	13.41
iso-Butyl	A	85.3	57	$C_{10}H_{13}O_5NS$	12.35	12.34
n-Amyl	A	70.5	56	$C_{11}H_{15}O_5NS$	11.72	11.87
iso-Amyl	A	70.5	62	$C_{11}H_{15}O_5NS$	11.72	11.77
Allyl	A	84.4	74.5	$C_9H_9O_5NS$	13.16	13.27
β-Trichloroethyl	B	64.4	119	$C_9H_8O_5NCl_3S$	9.56	9.55
β-Tribromoethyl	B	74.8	125	$C_9H_8O_5NBr_3S$	6.83	6.92

* Reported (ref. 2) 92°; (ref. 1) 91°; (ref. 5) 92–92.5°.

TABLE IV

2-Nitrobenzenesulfonates

ESTER	METHOD	% YIELD	M.P. °C.	FORMULA	SULFUR, %	
					Calcd.	Found
Methyl	A	88.9	60	$C_7H_7O_5NS$	14.74	14.81
Ethyl	A	82.3	34*	$C_8H_9O_5NS$	13.85	13.84

* Reported (ref. 2) 15° and b.p. 163–164° (abs. vacuum).

TABLE V

3-Nitrobenzenesulfonates

ESTER	METHOD	% YIELD	M.P. °C.	FORMULA	SULFUR, %	
					Calcd.	Found
Methyl	A	64.9	89	$C_7H_7O_5NS$	14.74	14.69
Ethyl	A	58.2	37*	$C_8H_9O_5NS$	13.85	13.74
n-Amyl	A	42	liq.	$C_{11}H_{15}O_5NS$	—	—

* Reported (ref. 2) 42°.

TABLE VI

Hydrochlorides of metanilic acid esters

ESTER	% YIELD	M.P. °C.	FORMULA	NEUTRAL EQUIVALENT	
				Calcd.	Found
Methyl	64.8	340 dec.	$C_7H_{10}O_3NClS$	223.5	221.9
Ethyl	74.2	340 dec.	$C_8H_{12}O_3NClS$	237.5	235
n-Amyl	42	340 dec.	$C_{11}H_{18}O_3NClS$	279.5	278.7

The methyl and n-amyl metanilates were similarly prepared and treated as was the ethyl ester above. Precipitation of the solids from absolute ethanol with

TABLE VII

Hydrochlorides of Sulfanilic Acid Esters

ESTER	M.P. °C.	FORMULA	NEUTRAL EQUIVALENT	
			Calcd.	Found
Methyl*	340 dec.	$C_7H_{10}O_3NClS$	223.5	222.3
Ethyl*†	340 dec.	$C_8H_{12}O_3NClS$	237.5	237.2
n-Propyl*	320 dec.	$C_9H_{14}O_3NClS$	251.5	252.5
n-Butyl*	330 dec.	$C_{10}H_{16}O_3NClS$	265.5	266.1
iso-Butyl	330 dec.	$C_{10}H_{16}O_3NClS$	265.5	264.4
n-Amyl	330 dec.	$C_{11}H_{18}O_3NClS$	279.5	280.9
iso-Amyl	330 dec.	$C_{11}H_{18}O_3NClS$	279.5	273.1
β-Trichloroethyl	190	$C_8H_9O_3NCl_4S$	341	342
β-Tribromoethyl	175	$C_8H_9O_3NClBr_3S$	474.5	462.2

* Reported (ref. 3).
† Reported (ref. 6).

TABLE VIII

Sulfanilic acid esters

ESTER	METHOD	% YIELD	M.P. °C.	FORMULA	SULFUR, %	
					Calcd.	Found
Methyl	A	50.0	92[a]	$C_7H_9O_3NS$	17.11	17.12
Ethyl	A	74.2	79–80[b, e]	$C_8H_{11}O_3NS$	15.92	15.85
n-Propyl	A	48.7	41.5[c]	$C_9H_{13}O_3NS$	14.88	14.77
n-Butyl	A	67.8	liq.[d]	$C_{10}H_{15}O_3NS$	13.97	—
iso-Butyl	A	45.4	50	$C_{10}H_{15}O_3NS$	13.97	14.01
n-Amyl	A	58.7	41	$C_{11}H_{17}O_3NS$	13.17	13.11
iso-Amyl	A	50.1	33	$C_{11}H_{17}O_3NS$	13.17	13.06
β-Trichloroethyl	B	50.0	95	$C_8H_8O_2NCl_3S$	10.50	10.55
β-Tribromoethyl	B	46.8	133	$C_8H_8O_2NBr_2S$	7.31	7.37

[a] Reported (ref. 3) 92.5–93°.
[b] Reported (ref. 3) 78.5–79°.
[c] Reported (ref. 3) 42.5–43°.
[d] Reported (ref. 3) below 0°.
[e] Reported (ref. 6) 78–80°.

dry ether gave white acidic compounds identical in properties. The compounds were diazotized and coupled with β-naphthol to give a dye.

Anal. Calcd. for $H_2NC_6H_4SO_2OH$:N.E., 173. Found: N.E., 179.

The analytical samples of the ethyl and n-amyl metanilate hydrochlorides were separately retained in cork-stoppered bottles for eight years and then reanalyzed. Negative tests were obtained for hydrogen chloride and ethyl and n-amyl groups. Titration of each sample gave N.E. values of 175 and 174 re-

spectively. Thus hydrolysis of the ester hydrochlorides had occurred and low boiling components had evaporated leaving metanilic acid.

Stability of orthanilic acid esters

Ethyl orthanilate, obtained by method (A), was found to be a brown liquid solidifying at −31.5° and giving a hydrochloride decomposing at 340° with a N.E. of 237.4 (theoretical 237.5). The free amine, when treated in the same manner as was its meta isomer in the preceding experiment, hydrolyzed to form orthanilic acid containing a molecule of alcohol of crystallization.

Anal. Calcd. for $H_2NC_6H_4SO_2OH \cdot C_2H_5OH$: N.E., 219. Found: N.E., 208. The compound was diazotized and coupled in the same manner as its meta isomer to give a dye.

Stability of sulfanilic acid esters

The esters and hydrochlorides of this series appeared to be quite stable when prepared eight years ago. Recently the cork-stoppered analytical samples still available were reanalyzed to give the following data:

The n-propyl, iso-butyl and n-amyl sulfanilates were found to be sticky, unhomogeneous masses of ester, alcohol and free sulfanilic acid. Trituration of each sample with ether to remove the alcohol and unhydrolyzed ester left sulfanilic acid identified by N.E. values of 173, 174 and 175 respectively.

The n-propyl, iso-butyl and n-amyl sulfanilate hydrochlorides were found to give negative tests for hydrogen chloride and the alcohol moiety. Titration of the samples gave N.E. values of 175, 188, 175, and 177 respectively.

The β-trichloroethyl and β-tribromoethyl esters and hydrochlorides were found to be stable and unchanged in their analyses and properties still giving the same m.p. and N.E. values as reported in Tables VII and VIII.

SUMMARY

Twenty-four new esters of the isomeric nitro- and aminobenzenesulfonic acids have been prepared, characterized and their relative stabilities studied.

REFERENCES

(1) BELL, J. Chem. Soc. (2) 2776. 1928.
(2) DEMENY, Rec. trav. chim. **50**: 60. 1931.
(3) JENSEN, HANSEN, JORGENSEN AND SCHMITH, Dansk. Tids. Farm. **18**: 201. 1944. C.A. **40**: 1467. 1946.
(4) MARVEL AND SEKERA, "Organic Syntheses", Vol. XX, J. Wiley and Sons, Inc., New York, N. Y., 1940, p. 50.
(5) MORGAN AND CRETCHER, J. Am. Chem. Soc. **70**: 375. 1949.
(6) WALTER, J. Am. Chem. Soc. **65**: 739. 1943.

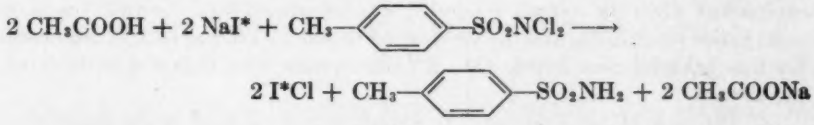
A STUDY OF THE CONDITIONS INVOLVED IN THE PREPARATION OF 3,5-DIIODO-4-OXO-1-PYRIDINE-ACETIC ACID (DIODRAST) CONTAINING IODINE-131

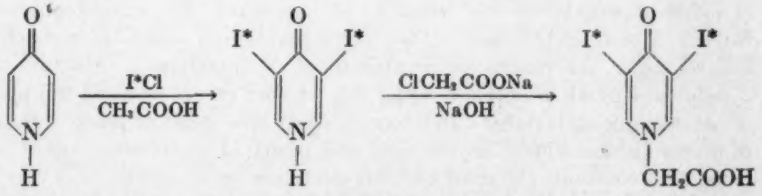
By Arthur Roe, R. L. Hayes, and H. D. Bruner

The Venable Chemical Laboratory and the Radioisotope Laboratory of the University of North Carolina
Chapel Hill, North Carolina

The compound 3,5-diiodo-4-oxo-1-pyridine-acetic acid, commonly called Diodrast (or sometimes diodone or perabodil) and usually employed in the form of the diethanolamine salt, has been extensively used for the clinical measurement of renal blood flow. It was of interest for several reasons to prepare the compound labeled with iodine-131; such a preparation had not been reported in the literature. No one of the several known methods of synthesis of diodrast proved to be entirely satisfactory when iodine-131 was involved because most of them employ an excess of the iodinating agent; this paper reports a satisfactory method of synthesis from 4-pyridone and sodium iodide-131 in yields of 84% (crude) and 73% (pure) based on the amount of sodium iodide-131 used. Synthesis using an exchange reaction between diodrast and sodium iodide-131 is currently being investigated.

The method chosen for the synthesis is illustrated in the accompanying equations; 4-pyridone is iodinated with iodine-131 monochloride to form 3,5-diiodo^{131}-4-pyridone; this compound when treated with monochloroacetic acid in alkaline solution forms the desired 3,5-diiodo^{131}-4-oxo-1-pyridine-acetic acid in good yield. The iodine-131 monochloride was prepared by allowing sodium iodine-131 to react with dichloramine-T.





Dohrn and Diedrich (1) have prepared inactive 3,5-diiodo-4-pyridone in good yield by iodination with iodine monochloride in dilute hydrochloric acid solution. Boyack, Moore, and Clausen (2) report the preparation of iodine-131 monochloride by the addition of sodium iodide-131 (along with inactive potassium

iodide as carrier) to an acetic acid solution of dichloramine-T; they used iodine-131 monochloride to prepare diiodo^{131}-fluorescein in excellent yield using acetic acid as a solvent for the reaction.

One of the goals of the present synthesis was to achieve as high a yield of diodrast as possible with respect to the sodium iodide used as the source of iodine-131; the advantage of iodine monochloride over elemental iodine in this respect is obvious. An attempt was made to adapt the method of Boyack, Moore, and Clausen (2) to the preparation of 3,5-diiodo^{131}-4-pyridone; the results at first were discouraging, but eventually a 91% yield of 3,5-diiodo^{131}-4-pyridone was realized. During the course of this investigation it was found that the following factors have a pronounced influence on the yield and purity of the 3,5-diiodo^{131}-4-pyridone obtained: (1) the point in the synthesis of iodine-131 monochloride at which the sodium iodide-131 is introduced; (2) the ratio of dichloramine-T used to that stoichiometrically required in the synthesis of iodine-131 monochloride; (3) the ratio of 4-pyridone used to that stoichiometrically required in the preparation of 3,5-diiodo^{131}-4-pyridone; (4) the ratio of water to solvent acetic acid used. A discussion of these effects follows.

(1) The point at which the sodium iodide-131 was introduced in the preparation of iodine-131 monochloride was found to have a very decided effect on the yield of 3,5-diiodo^{131}-4-pyridone with respect to the iodine-131 used. If, as was first attempted, the solution of sodium iodide-131 was introduced before the inactive potassium iodide carrier, the yield based on the amount of iodine-131 used was approximately half the yield based on the total amount of iodide used. For example, in one preparation when the sodium iodide-131 was introduced first the yield based on total iodide was 68.0%, whereas the yield based on iodine-131, as determined by the radioactivity of the product, was only 32.8%. If, on the other hand, the sodium iodide-131 was introduced immediately after the potassium iodide carrier, the two yields were approximately equal; thus in one experiment when the sodium iodide-131 was introduced last, the yield based on total iodide was 67.9%, and the yield based on iodide-131 was 68.1%. No reason for this behavior was found. (Much better yields were obtained in later experiments.)

(2) The ratio of dichloramine-T to sodium iodide-131 used in the preparation of iodine monochloride was found to be important. The directions given by Boyack, Moore, and Clausen (2) for the preparation of iodine-131 monochloride call for twice the stoichiometric amount of dichloramine-T. Analysis of the 3,5-diiodo-4-pyridone obtained using this twofold excess revealed the presence of considerable chlorinated 4-pyridone. A study was therefore made of the effect of excess dichloramine-T on the yield and purity of the product, other factors being held constant; the results of this study are shown in Fig. 1. It was found that an excess of dichloramine-T was necessary to prevent decomposition of iodine monochloride during the reaction with 4-pyridone; however, too great an excess brought about chlorination of the 4-pyridone. Under the conditions employed in this study the best yield of pure 3,5-diiodo^{131}-4-pyridone was obtained using 1.05 times the stoichiometric amount of dichloramine-T. A study

of the other factors discussed below revealed, however, that higher yields of 3,5-diiodo^{131}-4-pyridone could be obtained using 1.10 times the stoichiometric amount of dichloramine-T.

(3) Experiment showed that it was advantageous to employ an excess of 4-pyridone over that required for reaction with the iodine monochloride present. To determine the optimum amount of 4-pyridone, studies were made of the effect of varying the amounts of excess 4-pyridone on the yield of 3,5-diiodo-4-pyridone. Three parallel studies were carried out using 1.025, 1.050, and 1.100 times the stoichiometric amount of dichloramine-T. All samples of 3,5-diiodo-4-pyridone

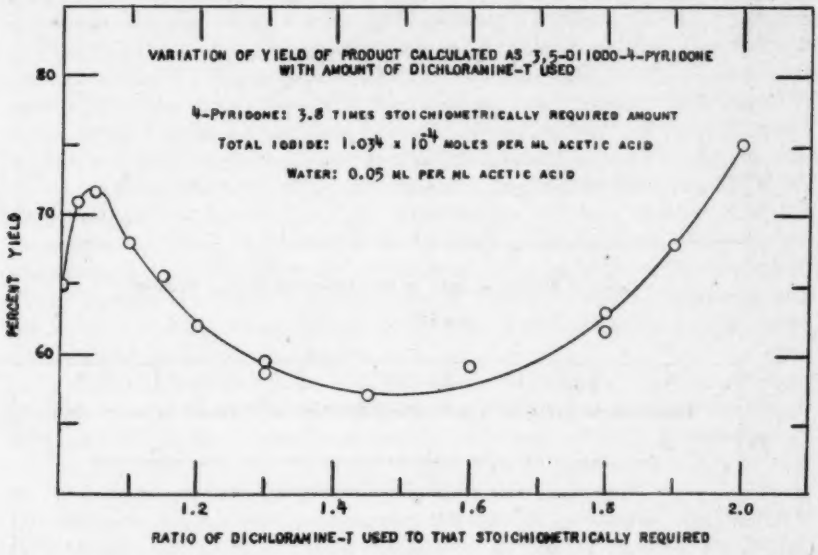


FIG. 1

prepared in this series of runs were pure, as indicated by iodine analysis. The results are shown in Fig. 2. As expected, the yield increased as the amount of excess 4-pyridone decreased. However, a maximum was reached in the neighborhood of 1.66 mole excess of 4-pyridone, after which the yield dropped; in each case this decrease in yield was attended by a more rapid onset and greater amount of decomposition of iodine monochloride. Using a large excess of 4-pyridone, the relative yields obtained with the three different amounts of dichloramine-T employed were those to be expected from the results shown in Fig. 1; however, using less than a twofold excess of 4-pyridone a reversal occurred, and the best yield of 3,5-diiodo-4-pyridone was obtained using 1.100 times the required amount of dichloramine-T rather than the 1.05 excess which Fig. 1 shows to be best.

Examination of Fig. 2 would indicate that the use of more than 1.10 times the

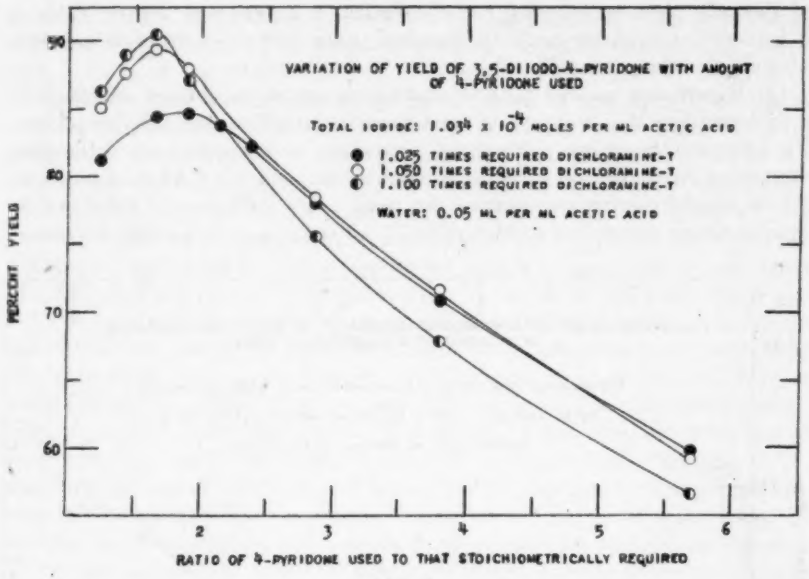

VARIATION OF YIELD OF 3,5-DIIODO-4-PYRIDONE WITH AMOUNT OF 4-PYRIDONE USED
TOTAL IODIDE: 1.03⁴ x 10⁻⁴ MOLES PER ML ACETIC ACID
1.025 TIMES REQUIRED DICHLORAMINE-T
1.050 TIMES REQUIRED DICHLORAMINE-T
1.100 TIMES REQUIRED DICHLORAMINE-T
WATER: 0.05 ML PER ML ACETIC ACID
PERCENT YIELD
90
80
70
60
2
3
4
5
6
RATIO OF 4-PYRIDONE USED TO THAT STOICHIOMETRICALLY REQUIRED

FIG. 2

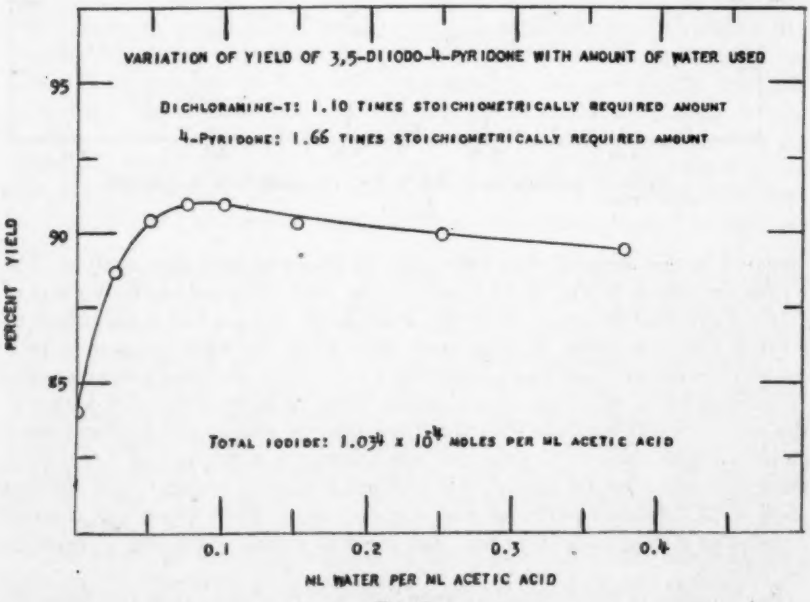

VARIATION OF YIELD OF 3,5-DIIODO-4-PYRIDONE WITH AMOUNT OF WATER USED
DICHLORAMINE-T: 1.10 TIMES STOICHIOMETRICALLY REQUIRED AMOUNT
4-PYRIDONE: 1.66 TIMES STOICHIOMETRICALLY REQUIRED AMOUNT
TOTAL IODIDE: 1.03⁴ x 10⁻⁴ MOLES PER ML ACETIC ACID
PERCENT YIELD
95
90
85
0.1
0.2
0.3
0.4
ML WATER PER ML ACETIC ACID

FIG. 3

required dichloramine-T would increase the yield still further. A run was made using 1.15 times the stoichiometric amount of dichloramine-T; the yield was not as good as that reported above and analysis of the product showed it to contain only 98.9% of the necessary iodine, indicating that some chlorination had taken place.

(4) The use of an aqueous solution of sodium iodide-131 is the most convenient method of introducing it in the preparation of iodine-131 monochloride; a study was therefore made of the effect on the yield and purity of 3,5-diiodo^{131}-4-pyridone of diluting the solvent (acetic acid) with various amounts of water. The results of this study, in which 1.66 times the stoichiometric amount of 4-pyridone and 1.10 times the required amount of dichloramine-T were used, are shown in Fig. 3. All products were pure except that obtained in glacial acetic acid; presumably chlorination occurred here, as the product contained only 98.3% of the theoretical iodine. The yield remained approximately constant from a volume ratio of water to acetic acid of 0.375 down to a ratio of 0.050; thereafter it dropped decidedly. Here again, the decomposition of iodine monochloride, which occurred in the more concentrated acid solutions, appears to be the reason for this decrease in yield. With the use of larger amounts of water the preparation was rendered difficult by initial decomposition of the iodine monochloride which resulted in the collection of elemental iodine in the condenser. On the basis of this study a volume ratio of water to acetic acid between the limits of 0.075 and 0.100 was chosen as the best concentration to employ in the synthesis of 3,5-diiodo^{131}-4-pyridone.

No difficulty was experienced with formation of 3,5-diiodo^{131}-4-oxo-1-pyridine acetic acid from 3,5-diiodo^{131}-4-pyridone using an adaptation of the method of Baker and Briggs (3) for inactive material; yields were excellent in this step.

EXPERIMENTAL

In all studies on the factors influencing the yield of 3,5-diiodo^{131}-4-pyridone a constant total iodide concentration of 1.034×10^{-4} moles of iodide per ml. of acetic acid was employed. In all reactions reflux was continued until the reaction had approached completion, as evidenced by a complete or near complete discharge of color in the reaction mixture, or until extensive decomposition of iodine monochloride had set in, as indicated by the presence of free iodine. The yields of 3,5-diiodo^{131}-4-pyridone with respect to total iodide used were determined by collecting the products in weighed sintered glass crucibles; yields with respect to iodide-131 were determined by comparison of the radioactivity of the products with a standard dilution of the sodium iodide-131 solution used.

The analyses for iodine in 3,5-diiodo-4-pyridone were carried out by oxidation with acid permanganate using a modification of a method for diodrast reported by White and Rolf (4). On analysis the products obtained under the conditions indicated in Fig. 1 were found to be pure when less than 1.3 times the stoichiometric amount of dichloramine-T was used; beyond this limit the products became progressively more impure. The product obtained using 1.45 times the required dichloramine-T contained only 97.5%, and that obtained using 2.00

times the required dichloramine-T contained only 86.8% of the necessary iodine; the presence of chlorine in this product was established. All compounds obtained in the study shown in Fig. 2 were pure as shown by iodine analysis; likewise all products indicated in Fig. 3 were pure with the exception of the run made in glacial acetic acid. This product contained only 98.3% of the required iodine. To insure detection of all impurities all analyses were made on the crude products.

All operations with iodine 131 were carried out in a hood and monitored with a Tracerlab Monitor SU 3A. The operators wore rubber gloves, lead bricks were employed for shielding purposes, and a mirror was used for observations of the reaction mixture when long periods of reflux were required. Counting was done with an El-Tronics Scaler using an end-window thin-wall G. M. tube.

Preparation of Diodrast-I^{131}: The 4-pyridone used was prepared by the thermal decarboxylation of chelidamic acid (5) and was purified by distillation, recrystallization from water, precipitation from absolute alcohol with absolute ether, and drying at 115–120°; m.p. 148.5°. The dichloramine-T used was prepared by a method described by Krauss (6) and was purified by recrystallization from carbon tetrachloride; m.p. 83°. All materials used were stored over phosphorous pentoxide.

3,5-Diiodo^{131}-4-Pyridone: Exactly 1.100 g. of dichloramine-T was placed in a 250-ml. flat-bottomed flask with a 24/40 standard taper ground glass joint; 30 ml. of glacial acetic acid was added, and solution effected by heating. The flask was cooled to room temperature, 1.38 g. C. P. potassium iodide added, and the contents swirled until the iodide dissolved and the orange color of iodine monochloride appeared. The desired quantity of carrier-free iodine-131 as 3–4 ml. of an aqueous solution of sodium iodide-131 was introduced followed by 0.656 g. 4-pyridone. During the above additions, a further 10 ml. of glacial acetic acid was utilized in washing down the neck of the flask; at this point a total volume of 40 ml. of acetic acid had been used. A glass-sealed magnetic stirring bar was introduced, the flask fitted with a Liebig condenser, placed in a heating mantle, and the contents brought to reflux. Stirring was effected by a magnetic stirrer placed beneath the heating mantle. Precipitation of 3,5-diiodo^{131}-4-pyridone began before reflux had set in, and in order to prevent serious bumping after reflux had started it was necessary to maintain continuous and rapid stirring during the whole of the reflux period. Reflux was continued for five hours after which time the reaction mixture was colorless. After adding 46 ml. of water and cooling the flask in an ice bath for thirty minutes, the 3,5-diiodo^{131}-4-pyridone was filtered in the flask by introduction of a filter stick 10 mm. in diameter. The filter stick was connected to a filter flask which acted as a receiver for the filtrate, and thence through a trap to an aspirator. The filtered 3,5-diiodo^{131}-4-pyridone was then washed three times with ice water and used directly in the preparation of diodrast-I^{131}.

3,5-Diiodo^{131}-1-Oxo-1-Pyridine-Acetic Acid: Any adhering 3,5-diiodo^{131}-4-pyridone was washed from the filter stick as it was removed from the flask by the use of approximately 10 ml. of water; 2 ml. of a solution containing 0.57 g. of sodium hydroxide was added and the 3,5-diiodo^{131}-4-pyridone brought into

solution by heating. The flask was fitted with an adapter holding a Liebig condenser and an addition funnel, and, when the solution had reached the boiling point, 0.71 g. of monochloroacetic acid was added through the condenser, several ml. of water being used to wash down the condenser after the addition; the solution was stirred vigorously during this addition. The solution was refluxed for one and one-half hours, and then, while the solution was still hot, 1.75 ml. of concentrated hydrochloric acid in 2.5 ml. of water was added with vigorous stirring at a rapid rate through the addition funnel. After crystallization had set in, the flask was cooled for thirty minutes in an ice bath and the contents filtered in the flask as before with the aid of a filter stick; the diodrast-I^{131} was washed three times with the use of a minimum amount of ice water. A quantity of water (approximately 45 ml.) sufficient to bring the diodrast into solution on refluxing was added, 0.1 g. charcoal introduced, and the hot solution, after refluxing for several minutes, filtered with the aid of suction through two thicknesses of filter paper. The receiving filter flask was cooled in an ice bath for thirty minutes, and the precipitated diodrast-I^{131} transferred quantitatively, with the use of as little ice water as possible, to a weighed sintered glass crucible. The crucible was dried at 110° for two and one-half hours, placed in a desiccator, and then weighed. The crucible together with its known weight of diodrast-I^{131} was next placed in a Gooch funnel, the tip of which extended well into the neck of a 25 or 50 ml. volumetric flask which was in turn placed in a large filter flask. An amount of 0.5 N sodium hydroxide which was 2 or 3 ml. in excess of the volume necessary to dissolve the diodrast-I^{131} was run into the crucible from a burette. The addition was made in small portions, the contents of the crucible being thoroughly stirred with a pointed stirring rod after each addition and the dissolved diodrast-I^{131} then drawn with suction into the volumetric flask. After washing the crucible with small portions of distilled water, the calculated volume of 0.5 N hydrochloric acid required for back titration of the excess base was added and the flask then diluted to the mark.

In a typical preparation, where approximately 10 millicuries of sodium iodide-131 was employed, the yield of purified diodrast-I^{131} was 73.5% based on the amount of sodium iodide-131 used. The filtrate from the recrystallization of the crude diodrast-I^{131} contained 10.5% of the iodine-131 used, indicating a crude yield of 84.0%. A further 13.3% of the radioactivity was found in all other filtrates and washings, indicating a 97.3% recovery of the iodine-131 used.

Acknowledgment: This research was supported in part by a grant from the Office of Naval Research, Contract No. N8onr 60500. The iodine 131 used was received on allocation from the U. S. Atomic Energy Commission, Oak Ridge, Tennessee. Mr. R. L. Hayes was an A. E. C. Predoctoral Fellow, 1948–1950 (Fellowship administered by the National Research Council).

SUMMARY

3,5-Diiodo-4-oxo-1-pyridine-acetic acid containing iodine-131 has been synthesized in good yield; a study of the conditions involved in the reaction is reported.

REFERENCES

(1) DOHRN AND DIEDRICH. Ann. **494**: 284. 1932.
(2) BOYACK, MOORE, AND CLAUSEN. Neuclonics **3**: No. 4: 62. 1948.
(3) BAKER AND BRIGGS. J. Soc. Chem. Ind. **62**: 189. 1943.
(4) WHITE AND ROLF. Pro. Soc. Exptl. Biol. Med. **43**: 1. 1940; C.A. **34**: 2006. 1940.
(5) EMMERT AND DORN. Ber. **48**: 687. 1915.
(6) KRAUS. Am. J. Pharm. **90**: 16. 1918.

THE ODORS OF MONO- AND DIARYLALKANES

By Walter H. Hartung and Henry Dale Smith

School of Pharmacy, University of North Carolina
Chapel Hill, North Carolina

While pursuing studies with palladium catalysis Hartung and Hartung (1) reduced benzalacetophenone to 1,3-diphenylpropane. This hydrocarbon is not new (2), but the ease with which it may be obtained, its pleasant odor, and also the fact that monoarylalkanes possess distinctive odors (3) suggested the desirability of examining and comparing these and related substances for the relationship between their odors and chemical structure. The first study of such a comparison has been made possible by a grant from the Carnegie Foundation for the Advancement of Teaching, which is hereby gratefully acknowledged.

A tabular listing of the compounds thus far considered will serve to show their structural relationships and permit discussion of their aromas.

There is no satisfactory standard for measuring the quality or character of odors. Hence, for the present purposes only a general discussion and comparison will be attempted, and these will be given in brief paragraphs or sentences.

1. The most pleasant odors are found in the mono- and diaryl-propanes. Present evidence suggests that the corresponding methanes and ethanes are appreciably if not decidedly inferior to the propane homologs. The higher homologs, in so far as they have been compared, are also inferior. As evidence of this conclusion the following details may be cited:
   a) Phenylethane (II) is very reminiscent of toluene (I), whose odor is familiar. Phenylpropane (III) is much sweeter and, though not altogether pleasant, much less objectionable.
   b) The p-alkylanisoles, VI, VII, VIII, IX and X, compose an interesting series of homologs. The introduction of the p-methyl group into anisole, i.e., the methyl ether of p-cresol (VI), is markedly pleasanter than the unsubstituted anisole; p-ethylanisole (VII) is decidedly more pleasing; p-n-propylanisole (VIII) is very refreshing, quite like anethole; p-n-butyl-anisole (IX) is less pleasant again, perhaps even less so than the lower ethyl homolog.
   c) Methylenedioxyphenylmethane (XI) and methylenedioxyphenylpropane (XII) form a most unusual pair of homologs. The methane derivative is not pleasant, somewhat suggestive of naphthalene. The propane homolog, therefore, comes as a pleasant surprise with an odor as refreshing as that of safrole itself.
   d) The diphenylalkanes also fit into this general scheme. 1,3-Diphenylpropane (XV) is quite floral, suggestive of roses or iris. Diphenylmethane (XIII) is not unpleasant but certainly not floral. Diphenylethane (XIV) is, perhaps, intermediate between the two. Diphenylbutane (XVI) is again less pleasing, and 1,5-diphenylpentane (XVII) is practically odorless.

2. The introduction of a p-methyl group probably increases the pleasantness. The following observations are cited:
   a) p-Xylene (IV) is the least objectionable of the three isomeric dimethylbenzenes.

TABLE I

Monoarylalkanes

ARYL GROUP	METHANES	ETHANES	PROPANES	BUTANE
C_6H_5- (Phenyl)	$C_6H_5CH_3$ (I)	$C_6H_5CH_2CH_3$ (II)	$C_6H_5CH_2CH_2CH_3$ (III)	
C_7H_7- (p-Tolyl)	$C_7H_7CH_3$ (IV)	$C_7H_7CH_2CH_3$ (V)		
C_7H_7O- (p-Methoxy-phenyl-)	$C_7H_7OCH_3$ (VI)	$C_7H_7OCH_2CH_3$ (VII)	$C_7H_7OCH_2CH_2CH_3$ (VIII)	$C_7H_7OCH_2CH_2CH_2CH_3$ (IX)
			$C_7H_7OCH_2CHCH_3$ | CH_3 (X)	
$C_7H_5O_2$- (3,4-Methylene-dioxyphenyl-)	$C_7H_5O_2CH_3$ (XI)		$C_7H_5O_2CH_2CH_2CH_3$ (XII)	

II, III, V, and VII were prepared by catalytic hydrogenolysis of corresponding ketone, Ar-CO-R.

IV obtained from Eastman Kodak Company.

VI and XI prepared by hydrogenolysis of corresponding aldehyde, Ar-CHO.

VIII and XII were prepared by hydrogenation of corresponding unsaturated compounds, anethole and isosafrole, respectively.

IX and X prepared by hydrogenolysis of corresponding carbinol intermediate, Ar-CHOH-R; the carbinol was obtained from the corresponding aldehyde, Ar-CHO and alkyl Grignard reagent.

   b) p-Ethyltoluene (V) is devoid of much of the toluene-like odor of ethyl benzene (II).
   c) 1-Phenyl-3-p-tolylpropane (XXII) is certainly as pleasant, and perhaps more so, than 1,3-diphenylpropane (XV).
3. The presence of a p-methoxyl group improves the odor of the monophenyl-

TABLE II

Diarylalkanes

METHANES	ETHANES	PROPANES	BUTANE	PENTANE
C_6H_5 | CH_2 | C_6H_5 (XIII)	C_6H_5 | CH_2 | CH_2 | C_6H_5 (XIV)	$C_6H_5CH_2CH_2CH_2—C_6H_5$ (XV) $C_6H_5—CH—CH_2CH_2—C_6H_5$ | Cl (XVIII)	C_6H_5 | CH_2 | CH_2 | CH_2 | CH_2 | C_6H_5 (XVI)	C_6H_5 | CH_2 | CH_2 | CH_2 | CH_2 | C_6H_5 (XVII)
C_6H_5 | $CH—CH_2CH_3$ | C_6H_5 (XIX)	C_6H_5 | $CH—CH_3$ | CH_2 | C_6H_5 (XX)	$C_6H_5—CH_2CHCH_3—C_6H_5$ | CH_3 (XXI) $C_6H_5—CH_2CH_2CH_2—C_6H_4—CH_3—p$ (XXII) $C_6H_5—CH_2CH_2CH_2—C_6H_4—OCH_3—p$ (XXIII) $C_6H_5—CH_2CH_2CH_2—C_6H_4—OC_2H_5—O$ (XXIV) $C_6H_5—CH_2CH_2CH_2—C_6H_3:O_2CH_2—m,p$ (XXV)		

XIII was purchased from Eastman Kodak Company.

XIV prepared by hydrogenolysis of benzoin (1).

XV, XXII, XXIII, XXIV and XXV were prepared by the hydrogenation of the corresponding benzalacetophenone intermediate, $C_6H_5—CO—CH:CH\text{-}Ar$, each of which was prepared from acetophenone and the appropriate aromatic aldehyde according to the directions for the synthesis of benzalacetophenone (4).

XVI prepared by the hydrogenolysis of 1,4-diphenyl-1-butanol; this was prepared by the reaction of hydrocinnamylmagnesium bromide on benzaldehyde (5).

XVII prepared by the reduction of cinnamalacetophenone.

XVIII obtained by the reaction of 1,3-diphenyl-1-propanol with hydrochloric acid; the intermediate carbinol was obtained by the reduction of benzalacetophenone (1).

XIX prepared by the hydrogenolysis of diphenylethylcarbinol; the carbinol was prepared from phenylmagnesium bromide and propiophenone (6).

XX prepared via 1,2-diphenyl-2-propanol by hydrogenolysis; the carbinol was obtained from phenylmagnesium and phenylacetone.*

XXI prepared via the carbinol intermediate obtained from the reaction of benzylmagnesium chloride with phenylacetone.* The identity of this hydrocarbon as obtained is open to doubt.

* The phenylacetone was supplied through the courtesy of Dr. M. L. Moore, Smith, Kline and French Laboratories, Philadelphia.

alkanes. In the diphenylalkanes it probably has no corresponding effect. The following observations support these conclusions:

a) The p-alkylanisoles are better than the corresponding alkylbenzenes or p-alkyltoluenes; e.g., VII is preferred to V and VIII is better than III.
b) 1-Phenyl-3-p-methoxyphenylpropane (XXIII) is not as desirable as diphenylpropane (XV) or phenyltolylpropane (XXII).
c) From observations recorded some time ago (3) it is known that p-n-propylanisole (VIII) is much better than m-n-propylanisole; and o-n-propylanisole is quite bitter.

4. The introduction of the o-ethoxyl group into diphenylpropane detracts from the favorable properties of the parent hydrocarbon.
5. The introduction of the methylenedioxy group into the 3,4-position of phenylpropane (XII) produces its own characteristic modification in the odor, yet produces a pleasing and refreshing effect.
6. It is possible that the presence of the methoxyl-, the ethoxyl- and the methylenedioxy-groups into diphenylpropane increases the vapor pressure to such an extent that their concentration in the atmosphere is below a favorable olfactory threshold.
7. The presence of a chlorine atom in the chain of diphenylpropane (XVIII) does not appreciably modify the odor.
8. The unbranched propane chain, and without further alkyl substitution in the chain, is superior. This is shown by:
   a) The pleasing character of the odor increases as one passes from 1,1-diphenylpropane (XIX) to 1,2-diphenylpropane (XX), reaching the peak in the isomeric 1,3-diphenylpropane (XV).
   b) 1,3-Diphenyl-2-methylpropane (XXI) is less pleasant.
   c) Isobutylanisole (X) is less desirable than p-n-propylanisole (VIII); although it is probably superior to p-n-butylanisole (IX).

SUMMARY

A comparison is made of the odors of twelve monoarylalkanes and thirteen diarylalkanes. In these compounds it is observed that the most favorable odors are associated with a straight-chain, unsubstituted propane chain. The presence of methyl, methoxyl and methylenedioxy groups in the aromatic nucleus of n-propylbenzene increases the pleasing properties. In the diarylalkanes, i.e., propanes, the effect is not so regular.

REFERENCES

1. HARTUNG AND HARTUNG, unpublished.
2. BEILSTEIN. 1922. Handbuch der Organischen Chemie. 4th ed. Vol. V, p. 613.
3. HARTUNG AND CROSSLEY. 1934. J. Am. Chem. **56**: 158.
4. Organic Syntheses.
5. BEILSTEIN. 1930. Handbuch der Organischen Chemie. 4th ed. Suppl. to Vol. V, p. 290.
6. BEILSTEIN. 1922. l.c., p. 614.

A STUDY OF THE TRANSLOCATION OF RADIOACTIVE PHOSPHORUS IN LOBLOLLY PINE (PINUS TAEDA L.)*

By Donald E. Moreland

Division of Biological Sciences: Botany
North Carolina State College, Raleigh, North Carolina

Introduction

Information relative to the translocation and distribution of inorganic solutes and organic compounds and to the factors which influence these movements is essential for the interpretation and control of plant behavior. The problem of solute transport in herbaceous plants is still receiving active study. Much less attention, however, has been given the subject of solute movement in tree species. A knowledge of the physiological processes of trees is needed by the silviculturist and forest manager. Comprehension of the factors affecting the growth, development, and reproduction of commercially and economically important tree species is a prerequisite to successful forest management.

Several excellent reviews and critical discussions of solute translocation in plants have been published (Huber, 1932; Clements, 1934; Curtis, 1935; Mason and Phillis, 1937; and Crafts, 1939). Therefore, no attempt will be made to present an extended discussion of past work in this paper.

Solute transport was one of the first problems to interest students of plant physiology. Stephen Hales in 1727 reported the results of some of the earliest work attempted in this field. Since then, many investigators, using various techniques, have published the results of their studies on solute movement. The majority of these investigations, however, are subject to criticism because of the experimental procedures employed. Much of the work was based upon the application of indicators such as dyes or lithium salts, compounds not normally present in the xylary translocating system, to cut or severed surfaces. In intact plants the conducting systems are closed and the xylary system often exhibits tensions or pressures. Artificial openings into the conductive tissues introduce new factors which make the interpretation of experimental results questionable.

The development of suitable techniques utilizing radioactive isotopes permits studies of translocation to be made with arboreous vegetation under field conditions. In addition, it may be possible to eliminate many of the shortcomings and failures which characterize some of the original experimental techniques. Radioisotopes of several of the elements essential for normal plant growth are obtainable. These can be introduced to the transpiration stream through active absorption by meristematic root apices, the manner in which mineral elements enter the plant normally. When a radioelement is introduced directly into a plant or placed in its environment, the movement and presence of the

* Based on data presented in a thesis submitted to the faculty of North Carolina State College for the degree of Master of Science in Forestry.

radioactive variety can be traced independently of the stable isotopes of the same element already present in the system. This can be done rather easily and with a high degree of accuracy by detecting with suitable instruments the radiation emitted by the radioisotopes in attaining nuclear stability. Radioactive isotopes up to the instant of decay are, with the exception of a slight difference in mass, chemically and physically very similar to the normal isotopes of the same element. These differences are so small that it can be assumed that the isotopes of a given element are not utilized preferentially by the living organism. Injury to living cells may occur when high concentrations of radioelements are used; however, in biological investigations levels of activity are selected to minimize any injurious effects. It was assumed that the emitted radiation, under the conditions of this investigation, did not interfere with the normal physiological activities of the living cells of the trees that were treated.

The data presented here are the results of an exploratory study on loblolly pine (*Pinus Taeda* L.). Following these preliminary trials a general investigation has been initiated relative to the translocation of mineral salts in the roots and stems of certain species of trees under different seasonal and environmental conditions using radioactive isotopes.

MATERIALS AND METHODS

Phosphorus was selected for use in this investigation because of its physiological importance and the availability of a suitable radioactive isotope (P^{32}). It is one of the mineral elements essential to normal plant growth and is universally present in all forms of plant life. Past studies (Hevesy et al, 1936, 1937; Biddulph, 1940; Arnon et al, 1940) have shown that phosphorus is highly mobile within the plant and is readily redistributed from one plant organ to another. Small glass vials containing 25 milliliters of a prepared radioactive phosphorus solution with an adjusted pH of 5 were used in the field. Each milliliter of solution contained 140 micrograms of normal phosphorus and had a P^{32} activity level of 10 microcuries. It is not known if this one-salt solution had a toxic effect on the meristematic cells of the root tip. No indication was obtained of the magnitude of toxicity or of its influence, if any, on the rates of movement as obtained in this investigation under the short periods of time treatment was in progress. Additional study will have to be made of this point before a definite answer is available.

Plantation grown loblolly pine saplings 11 and 12 years old ranging in diameter from three to six inches were selected for study. The technique followed in this investigation began with the location of functional terminal or lateral root tips. Suitable tips could be found either directly under the decaying mat of needles cast on the forest floor or in the upper few inches of soil. The rootlet was very carefully uncovered for a distance of approximately twelve inches from the tip. A depression was made to hold the vial containing the radioactive phosphorus solution and the intact attached tip was lowered into it. At the end of the treatment period, which extended up to 10 hours, the rootlet was severed and the vial and treated tip were removed. The root was then traced back to its junction with the stem and the tree was felled. Cross-sectional samples one-inch thick

were obtained from the stem and root at two-foot (61 cm.) intervals. Following removal of the bark the outer three rings of xylem were separated from the stem sections for analysis. Root samples and the selected stem xylary tissue were split into sections approximately $\frac{1}{8}$th-inch square and one-inch long. The "splinters" were placed in pyrex glass beakers of suitable sizes. Ashton (1936) has shown that in the presence of magnesium nitrate temperatures of 800°C. may be used without loss of phosphorus. Therefore, prior to ashing, the prepared samples were wetted with a minimum amount of 50 per cent ethyl alcohol to increase the penetration of the magnesium salt and flooded with a 5 per cent magnesium nitrate solution. Samples were next evaporated to dryness on an electric evaporating plate and were placed in an electric muffle furnace at a temperature of 250°C. After three hours, the temperature was raised to 450°C. and a clean, fluffy, white ash was obtained in approximately 12 hours. Each sample of ash was mixed thoroughly and representative decigram portions were weighed out and evenly distributed on $1\frac{1}{4}$-inch diameter aluminum counting discs. Disintegration activities were determined using standard laboratory Geiger scaling units. Counting data were corrected for background interference and the slight level of naturally occurring radioactivity present in control trees. Most of this can undoubtedly be attributed to a naturally occurring long-lived radioisotope of potassium, K^{40}. Activity over and above this absolute background value was interpreted as being due to P^{32}. The highest stem level at which a significant count could be recorded was selected to indicate the limits of movement of the introduced radiophosphorus.

EXPERIMENTAL RESULTS

The first treatments were made on August 31, 1949, in an 11-year-old loblolly pine plantation located near Franklin, Virginia. The fall phase of root development had begun and no difficulty was experienced in locating healthy functional root tips. Air temperatures ranged from 23.3°C. in the morning to 28.3°C. in the afternoon. The morning sky was clear with scattered clouds, a general overcast occurred about 1:00 P.M., and heavy rain fell in the late afternoon. Environmental conditions, considered as a whole, favored low to medium rates of transpiration. The mid-point of all treatments were centered as closely as possible at 12:30 P.M.

A partial summary of the results of this investigation is presented in Table 1. Rates of movement expressed both as feet and meters per hour are included in the last column. These figures indicate composite rates only since there was no way to separate root from stem movement. In addition, no allowance was made for time lapse between the absorption of an ion and its subsequent movement into the xylary elements and the sap stream pathway. However, comparisons between normal absorption by intact root tips and introduction of the tracer through severed root surfaces indicate that the initial absorption and release of an ion to the xylary translocation stream occurs almost immediately.

A second set of treatments was made on October 1, 1949, in a 12-year-old loblolly pine plantation at the Richlands Creek Farm Forest located approximately 6 miles northwest of Raleigh, North Carolina. Environmental conditions,

on the whole, should have been favorable for high rates of transpiration with considerable tension present in the xylary translocating system. The results of this treatment have also been included in Table 1.

TABLE 1

Summary of translocation rate studies on plantation grown loblolly pine saplings

DATE	TREE NO.	DIAM.*	STEM HEIGHT	TREATMENT TIME	LIMITS OF ACTIVITY			RATE OF MOVEMENT	
					Root	Stem	Total		
		In.	*Feet*	*Hours*	*Feet*	*Feet*	*Feet*	*Ft./hr.*	*M./hr.*
Aug. 31, 1949	1	4.8	26.9	9.90	5.5	22.0	27.5	2.78	0.85
	6	6.7	31.9	10.00	15.4	24.0	39.4	3.94	1.20
	11	4.6	28.4	5.90	5.1	14.0	19.1	3.24	0.99
	20	7.2	30.6	2.87	13.4	0.0	13.4	4.67	1.42
	21	3.8	26.9	0.73	3.0	0.0	3.0	4.11	1.25
Oct. 1, 1949	22	3.0	25.8	9.17	15.8	18.0	33.8	3.69	1.13

* Measured at 4.5 feet above average ground level.

TABLE 2

Distribution of radioactive phosphorus, P^{32}, in tree 6 (presented as counts per minute per decigram of ash)

ROOT (DISTANCE FROM STEM JUNCTION)	NET P^{32} ACTIVITY*	STEM (HEIGHT ABOVE ROOT JUNCTION)	NET P^{32} ACTIVITY*
Feet	*C/m/dg ash*	*Feet*	*C/m/dg ash*
0	919.20	2	162.48
2	1070.52	4	120.84
4	1566.12	6	187.14
6	3460.92	8	239.34
8	4101.00	10	204.48
10	5445.30	12	244.80
12	4620.54	14	163.86
		16	219.78
		18	105.82
		20	133.98
		22	78.80
		24	23.58†
		26	0.00

* Activity has been corrected for background interference.
† Limit of movement.

In the fall studies the fastest rates for combined stem and root movement were 1.20 and 1.13 meters per hour, respectively, for trees 6 and 22. The maximum translocation rates that have been obtained to date were 1.42 and 1.25 meters per hour for trees 20 and 21 which received comparatively short treatments. Movements here, however, were limited to the lateral roots.

Activity distribution levels for both root and stem sections of tree 6 are presented in Table 2. Trends in activity as shown here were typical of those

obtained for all trees in which a considerable range of movement was recorded. The extreme drop in activity between the root section at the stem junction and the first stem section, two feet above it, is also characteristic. This is another phase of the problem which requires further study before an explanation for the abrupt decrease in activity can be made.

An indication of the total radioactivity is not represented if upward movement occurred in more than the three outer growth rings in the lower stem sections. As was mentioned previously, only the outer three xylary rings were separated and ashed. The innermost rings were not considered primarily because the main objective here was to determine solely the presence of radioactive phosphorus and not the total activity at the various heights. MacDougal, Overton and Smith (1929) reported that the tension set up by the transpirational pull exerted by needles of the pine was directly transferred to the layers with which the needles were connected. This resulted in a more rapid movement of solutes through the second, third, and fourth annual layers nearest the cambium. Based on this information it was assumed that if the radioisotope was present at a particular height in the stem, it could be detected in the layers sampled.

GENERAL DISCUSSION

The rates for xylary translocation in loblolly pine saplings as determined in this study are for the most part higher than the published values obtained by other investigators. Groom (1910) reported rates varying from 0.3 to a maximum of 1.2 meters per hour for *Pinus sylvestris*. MacDougal (1926) indicated rates up to 0.15 meters per hour for *Pinus radiata*. Both of these investigators used dyes for indicators. Huber and Seith (Huber, 1932) using Thorium B as a tracer presented rates from 0.16 to 0.30 meters per hour for conifers in general. Huber and Schmidt (1936) found rates of movement difficult to measure in conifers with their thermoelectric method but reported that flow was mostly under 0.5 meters an hour. As far as could be determined there have been no data published previously relative to rates of movement in the lateral roots of conifers.

Rates of movement can be more fully appreciated if consideration is extended to the anatomical structure of the coniferous stem. Longitudinally oriented tracheids occupy 90 per cent of the total volume of the xylary stem tissue in loblolly pine (Forsaith, 1926). Vascular rays, radially aligned, and resin ducts, both horizontal and vertical, comprise the remaining 10 per cent. Brown, Panshin, and Forsaith (1949) report the mean length for the tracheid in the wood of *Pinus Taeda* to be 4.33 mm. with a standard deviation of 0.9 mm. The average distance covered by an ion moving in the sap stream passing in the longitudinal direction along a tracheal cavity is dependent not only on the length of the tracheid, but also on the overlap. Tracheal overlap is approximately one-fourth of a tracheid at each end (Stamm, 1946). Material being translocated may enter at any point over the overlap at one end and exit at any point in the overlap at the other end. The average tracheal path can be considered to be roughly three-fourths of a tracheal length. Stamm cites an average effective cavity tracheal length of 2.85 mm. for all softwood species. Thus, water and solutes in travel-

ling a distance of one meter along the stem longitudinally would have to pass into and through approximately 350 tracheids, according to his calculations. Conceivably, water and solutes moving longitudinally encounter a much greater resistance in the coniferous stem than in the angiospermous stem where vessels, xylary elements involved in the movement of water and solutes, sometimes attain a length of several meters.

The density of root tissue is less than that of stem tissue and root tracheids are longer and have a wider tangential diameter than those in the stem. In the macerated material examined tracheids as long as 9 millimeters were observed in root preparations. Walls of the root tracheids are also much thinner than those in the stem. Too, the extreme characteristic difference in cell wall thickness between spring- and summerwood tracheids is not apparent in the root elements. These structural differences may be correlated with reduced resistance to movement of the sap stream in the root. This in itself may partially account for the attainment of the fastest rates of movement in trees receiving short periods of treatment so that movement was limited to the lateral roots.

No attempt has been made to investigate the forces responsible for sap stream movement. This is still the subject of considerable controversy and is beyond the scope of the present study. As was stated previously, the objectives in the investigation being reported were to determine rates of movement and to develop techniques to be used in future studies.

SUMMARY

1. A technique has been presented for studying the rates and paths of mineral salt movement in tree species under field conditions using radioactive phosphorus, P^{32}, as a tracer.

2. The highest translocation rate obtained for the movement of P^{32} in the lateral roots of loblolly pine saplings was 1.42 meters per hour. The maximum determined rate for combined stem and root movement was 1.20 meters per hour.

3. Indications were obtained for faster movement in the lateral roots than in the stem. There is a direct correlation here between the anatomical structure of the two regions.

This study was conducted under contract with the Atomic Energy Commission through the Office of Naval Research. Radioactive phosphorus used in this investigation was supplied by the Oak Ridge National Laboratory, Oak Ridge, Tennessee, on allocation from the Isotopes Division, U. S. Atomic Energy Commission.

The writer wishes to express appreciation to Dr. D. B. Anderson for his assistance and guidance throughout the course of this investigation.

Appreciation is also extended to the staff of the North Coastal Plain Research Center, Southeastern Forest Experiment Station, United States Forest Service located at Franklin, Virginia, for their cooperation with the collection of the field data in the late August study.

LITERATURE CITED

ARNON, D. I., P. R. STOUT, AND F. SIPOS. 1940. Radioactive phosphorus as an indicator of phosphorus absorption of tomato fruits at various stages of development. Amer. Jour. Bot. **27**: 791–798.

ASHTON, F. L. 1936. Influence of the temperature of ashing on the accuracy of the determination of phosphorus in grass. Jour. Soc. Chem. Ind. **55**: 106T–108T.

BIDDULPH, O. 1940. Absorption and movement of radiophosphorus in bean seedlings. Plant Physiol. **15**: 131–136.

BROWN, H. P., A. J. PANSHIN, AND C. C. FORSAITH. 1949. Textbook of wood technology. Vol. 1. McGraw-Hill Book Company, Inc., New York.

CLEMENTS, H. F. 1934. Translocation of solutes in plants. Northwest Science **8**: 9–21.

CRAFTS, A. S. 1939. Movement of viruses, auxins, and chemical indicators in plants. Bot. Rev. **5**: 471–504.

CURTIS, O. F. 1935. The translocation of solutes in plants. McGraw-Hill Book Company, Inc., New York.

FORSAITH, C. C. 1926. The technology of New York State timbers. N. Y. State College of Forestry Tech. Publ. 18.

GROOM, P. 1910. Remarks on the oecology of the Coniferae. Ann. Bot. **24**: 241–269.

HEVESY, G., K. LINDERSTRØM-LANG, AND C. OLSON. 1936. Atomic dynamics of plant growth. Nature **137**: 66–67.

———, ———, AND ———. 1937. Exchange of phosphorus atoms in plants and seeds. Nature **139**: 149–150.

HUBER, B. 1932. Beobachtung und Messung pflanzlicher Saftströme. Ber. Deutsch. Bot. Ges. **50**: 89–109.

——— AND E. SCHMIDT. 1936. Weitere thermoelektrische Untersuchungen über den Transpirationsstrom der Baüme. Tharandter Forstl. Jahrb. **87**: 369–412.

MASON, T. G. AND E. PHILLIS. 1937. The migration of solutes. Bot. Rev. **3**: 47–71.

MACDOUGAL, D. T. 1926. The hydrostatic system of trees. Carnegie Inst. Wash. Publ. No. 373.

———, J. B. OVERTON, AND G. M. SMITH. 1929. The hydrostatic-pneumatic system of certain trees: movement of liquids and gases. Carnegie Inst. Wash. Publ. No. 397.

STAMM, A. J. 1946. Passage of liquids, vapors and dissolved materials through softwoods. U. S. D. A. Tech. Bull. No. 929.

SOME PHYSIOLOGICAL ASPECTS OF FERTILITY IN ACHLYA TUBERCULATA*

By A. W. Ziegler and Betty Linthicum

Department of Botany, Florida State University
Tallahassee, Florida

In the course of an investigation of the water molds of Leon County, Florida, the senior author of this article found an undescribed species of *Achlya*. This form, named *Achlya tuberculata*, was isolated from a water collection taken from a cypress swamp (Ziegler, 1950). A striking peculiarity of this fungus can be seen when it is grown in charcoal filtered distilled water. Under these conditions more than half of the oogonia that develop contain eggs which disintegrate before reaching maturity. If the fungus is grown in an oak leaf decoction, however, 94–98% of the oogonia formed contain entirely mature eggs. The authors felt that the prevention of egg disintegration might lie in compounds released by the oak leaves or in differences in hydrogen ion concentration. In order to ascertain the reason for this peculiarity, several tests involving different dilutions with a close check on pH have been performed. The results of these experiments are reported in this paper.

Although many references can be found concerning the relationship of pH to vegetative growth, the writers have been unable to find any expressly dealing with the effects of hydrogen ion concentration on the maturation of sex organs in this group. Couch (1945–1947) reports (personal communication) that he and his students have used oak leaves, leaf decoctions, and tannic acid solutions to induce egg maturation and normal antheridial development in species of *Achlya*. Miss Josephine Stewart (1946) also used dead oak leaves and oak leaf decoctions with *Rhizophidium coronum* and got the best growth of this form in oak leaf decoctions.

Experimental Results and Discussion

In the first experiment, hemp seed cultures of the fungus were placed in oak leaf decoctions. A strong solution was made using the dried leaves of *Quercus nigra* L. This was then diluted with sterile charcoal filtered water until 6 different preparations of the decoction had been prepared. These, tested on a Beckman electric potentiometer, gave pH values of 7.9, 7.7, 5.9, 5.3, 5.0, and 4.7. These are used for designating the various solutions. A control grown in charcoal filtered distilled water of a pH of 8.1 was also used. Cultures were placed in the preparations and remained there 19 days. In all cases in these experiments, the cultures placed in the various solutions were the same age and had approximately the same amount of vegetative growth.

After the elapsed time, the cultures were examined. Four separate counts of

* Contribution number 42, Botanical Laboratory, Florida State University.

100 oogonia each were made for the different pH concentrations of oak leaves. The results are given in Table I as averages.

From the results it can be seen that in the concentration yielding a pH of 5.0 nearly all the oogonia formed contained eggs all of which matured. It appears that the increasing concentration of the oak leaf decoction apparently stimulated the production of mature eggs. A corresponding decrease in oogonia containing only disintegrated eggs and those with both mature and disintegrated eggs can be seen as acidity increases. The pH 5.9, however, seemed to be an exception to this general rule and we are not able to account for this occurrence.

At the end of this portion of the experiments there was still some question whether pH or oak leaf decoction concentration accounted for the increase in egg maturation, or some other factor—such as tannic acid concentration—might have played some part in the results obtained. Therefore, buffer solutions were

TABLE I

pH	% OOGONIA WITH MATURE EGGS ONLY	% OOGONIA WITH MATURE AND DISINTEGRATED EGGS	% OOGONIA WITH DISINTEGRATED EGGS ONLY
	Control		
8.1	23	12	65
	Experimental Solutions		
7.9	39	9	52
7.7	33	8	59
5.9	In this pH, vegetative growth was abundant but oogonia were so scantily formed that a count comparable to any listed above was impossible.		
5.3	48	23	29
5.0	94	1	5
4.7	No growth occurred		

made up using Sørenson's phosphate buffer solutions (McLean, 1941). These were verified by an electric potentiometer. Solutions with the following pH values were used: 8.0, 7.5, 7.0, 6.5, 6.0, 5.5, 5.0, and 4.5. A hemp seed culture of the fungus was placed in each dish containing the buffer solution. They remained in the buffer solutions 15 days. Three to four separate counts of 100 oogonia each were made for each culture. The averaged results are listed in Table II.

It can be seen from the data that an increasing acidity produces an increase in the number of oogonia which form mature eggs entirely—from 3% in pH 8.0 to 94% in pH 4.5. With this increase, a corresponding decrease of oogonia containing only aborted eggs occurs—from 95% in pH 8.0 to 1% in pH 4.5. An interesting development may be noted in the oogonia which contain both mature and disintegrated eggs. In pH 8.0, 2% of the oogonia formed in this manner. This percentage gradually rises to 20 in pH 6.5 and then suddenly declines to 5% in pH 4.5. This seems to be closely correlated, however, with the fact that between pH 7.0 and 6.5 there is a remarkable change in the percentages of the

oogonia containing only mature eggs and those containing only aborted eggs. For the oogonia which contain only mature eggs there is a steady progression from the 3% in pH 8.0 to the 94% in pH 4.5. Likewise, there is a steady downward curve for the oogonia with only disintegrated eggs from 95% in pH 8.0 to 1% in pH 4.5.

In both experiments, egg and oogonia size were normal for any pH. Therefore, the pH concentration apparently has no effect on oogonial or egg measurements. In this species, diclinous antheridia are scantily formed and occur mainly in young cultures in water with or without the addition of oak leaves. Throughout these experiments, we have seen no indication that the oak leaf concentrations or buffer solutions either increased or inhibited the antheridial growth.

Although discrepancies exist between the data obtained for behavior in oak leaf water and in buffer solutions, a study of both shows certain similarities between them. In general, there is a marked abortion of eggs in the 7.0–8.0 range,

TABLE II

pH	% OOGONIA WITH MATURE EGGS ONLY	% OOGONIA WITH MATURE AND DISINTEGRATED EGGS	% OOGONIA WITH DISINTEGRATED EGGS ONLY
8.0	3	2	95
7.5	3	3	94
7.0	7	4	89
6.5	61	20	19
6.0	79	13	8
5.5	88	9	3
5.0	92	5	3
4.5	94	5	1

while almost complete egg maturity is attained in solutions of pH 4.5–5.5 except in the oak leaf decoction extract of pH 4.7 where all growth was inhibited. With the rise in the percentage of oogonia all of whose eggs mature, there is a corresponding decrease in the percentage of oogonia whose eggs have disintegrated. The results obtained for oogonia which form both mature and aborted eggs is somewhat similar in both instances. There is a gradual rise from a pH of about 8.0 to an acid condition of 5.3 in the oak leaf concentration and 6.5 in the buffer solutions and then a gradual drop to a negligible percentage. The high point of the curve in both cases can be correlated with a sudden increase in the percentage of oogonia with mature eggs only and a sharp decline of those oogonia which contain aborted eggs only.

SUMMARY

The eggs of *A. tuberculata* when grown in charcoal filtered distilled water show a marked tendency to disintegrate before maturity. If cultures of this form are grown in oak leaf decoctions or in buffer solutions of acid pH value, the tendency to abortion is greatly lessened. Solutions with pH values of 4.5 to 5.0 are best to induce the production of oogonia containing matured eggs. Oogonia contain-

ing large numbers of disintegrating eggs are found in the 7.0 to 8.0 range. The results seem to indicate that egg maturation is influenced by the hydrogen ion concentration rather than by the organic compounds released by the oak leaves. Oogonium, egg size, and antheridial growth are not affected by pH. It is emphasized that these results apply only to this particular species of *Achlya*.

The authors are indebted to Dr. J. N. Couch and Dr. F. G. Gustafson for reading the manuscript and making excellent suggestions.

LITERATURE CITED

COUCH, J. N. 1945–1947. Unpublished notes on the influence of leaf decoctions and tannic acid solutions on antheridial development and egg maturation in some species of Achlya.

MCLEAN, R. C., AND W. R. COOK. 1941. Plant Science Formulae, p. 179. Macmillan Company. London.

STEWART, JOSEPHINE. 1946. Unpublished thesis. Library of the University of North Carolina.

ZIEGLER, A. W. 1950. A new *Achlya* from Florida. Mycologia 42: 658–662.

STUDIES IN THE COMPOSITAE OF NORTH CAROLINA

III. An Enumeration of Noteworthy Distribution Records*

By R. K. Godfrey

Division of Biological Sciences: Botany, North Carolina State College
Raleigh, North Carolina

A previous similar enumeration of North Carolina composites was included in a paper on North Carolina vascular plants in general by Dr. William B. Fox and me,† and follows the general plan outlined therein. We expect to continue that series of notes on the distribution of North Carolina plants, but shall publish separately on the Leguminosae and Compositae, respectively, owing to certain practical considerations involving financial support for our field work. The field work and examination and study of herbarium material, which together resulted in these notes, was carried on while in residence in the Graduate School of Arts and Sciences of Duke University.

For the helpful criticism of Professor H. L. Blomquist, under whose guidance my work is presently proceeding, I hereby express my appreciation. I am grateful also for the courtesies and privileges which are always extended by Dr. A. E. Radford, Curator of the Herbarium, University of North Carolina, and by Dr. Thelma Howell, Director, Highlands Laboratory. To Dr. S. F. Blake, Botanist, Division of Plant Exploration and Introduction, Bureau of Plant Industry, Beltsville, Md., who read the manuscript and made helpful suggestions, I extend thanks.

The A. A. A. S. grant, through the North Carolina Academy of Science, awarded jointly to Dr. Fox and me in 1949, was used to defray a part of the expenses involved in my field work for the 1949 season.

Vernonia acaulis (Walt.) Gleason. Randolph County: along the railroad right-of-way, west of Ramseur, September 9, 1949, *Godfrey and Fox* 50297; dry sandy bank, 2 miles north of Randleman, June 29, 1927, *Wiegand and Manning* 3106 (in Gray Herb.); upland cut-over woods, on N. C. Rt. 902, 2.5 miles s.e. of Asheboro, July 5, 1949, *Fox* 2515; upland woods, on U. S. Rt. 64, 2 miles west of Asheboro, October 22, 1949, *Fox* 3501; Chatham County: abundant in a small, savanna-like bog just west of New Hope Creek, east of Pittsboro, along U. S. Rt. 64, August 21, 1949, *Godfrey and Fox* 50017; Anson County: shale bluff, Lane's Creek, 1.5 miles south of Rocky River, August 12, 1949, *Fox and Boyce* 2928.

* For the previous two papers in this series, see Godfrey, Studies in the Compositae of North Carolina, I. *Liatris*. Jour. Elisha Mitchell Sci. Soc. **64**: 241–259. 1948; II. The Compositae of Wake, Durham, and Orange Counties, l.c. **65**: 276–305. 1949.

† Fox, William B., and R. K. Godfrey, Notes on the Distribution of North Carolina Plants—I. Rhodora **51**: 129–146. 1949.

These are all piedmont stations for a plant heretofore not recorded for the piedmont province in North Carolina.

Elephantopus nudatus Gray. CHATHAM COUNTY: bog clearing, just west of New Hope Creek, east of Pittsboro, August 21, 1949, *Godfrey and Fox* 50018.

A plant primarily of the coastal plain, there being but one other record of its occurrence in the piedmont (Godfrey, 1949). This station extends it well into the latter province.

Eupatorium **Fernaldii**, nom. nov. (*Eupatorium album* L., var. *monardifolium* Fern. in Rhodora **39:** 451–453, 1937) BURKE COUNTY: broomsedge old field, along Catawba River opposite Rhodhiss, September 8, 1949, *Godfrey and Fox* 50282; BUNCOMBE COUNTY: abundant along railroad right-of-way, just east of Swannanoa, August 21, 1949, *Godfrey and Fox* 50010; RUTHERFORD COUNTY: abundant on steep hillside, cut-over woodland, south side of Lake Lure, August 16, 1949, *Godfrey and Fox* 49908; TRANSYLVANIA COUNTY: power line transect, steep mountain slope, just west of Horsepasture River, August 17, 1949, *Godfrey and Fox* 49953; MACON COUNTY: abundant in an old field, 4 miles east of Franklin, August 18, 1949, *Godrey and Fox* 49967.

Fernald (l. c.), in a synopsis of the varieties of *Eupatorium album* L., distinguished the variety *monardifolium* from the other varieties by its foliar characters, the leaves having coarser and more abundant teeth, harsher and firmer leaf-surfaces, rounded leaf bases and pinnate venation rather than tapering bases or 3-nerved venation. The heads of his var. *monardifolium*, however, are shorter, the phyllaries more herbaceous, much less attenuate at the tips than those of either var. *typicum* Fern. or var. *glandulosum* (Michx.) Fern. This fact is evident in the photographs accompanying the synopsis (l. c. Plate 484). In the field the former plant differs strikingly from the latter two, both in foliar characters and in the more technical characters of the heads. The differences being constant and clear-cut, I am giving it specific status which necessitates giving it a new name since "*monardifolium*" becomes a later homonym of *E. monardaefolium* Walp.

Eupatorium cuneifolium Willd. MOORE COUNTY: sandhills old field near Manly, along U. S. Rt. 1, September 15, 1949, *Godfrey* 50099.

The second record of occurrence in North Carolina, the other being for Brunswick County (Fox and Godfrey, 1949).

Liatris secunda Ell. ANSON COUNTY: turkey oak sand ridge near Sandy Plains Church, 1 mile west of N. C. Rt. 87, August 11, 1949, *Fox and Boyce* 2916.

Although most of the South Carolina citations of this species by Gaiser (1946) are from the sandhills region of the inner coastal plain, until now it has not been reported from the same physiographic region of North Carolina. All of ours have been from the two southeasternmost counties, New Hanover and Brunswick.

Chrysopsis pilosa Nutt. (*C. Nuttallii* Britton, not *C. pilosa* (Walt.) Britton in Small, 1933) HARNETT COUNTY: very abundant along the highway for 3–4 miles, approximately 3 miles southwest of Kipling, July 8, 1949, *Godfrey and Fox* 49428.

A plant of the South Central States, not previously recorded for our area, locally abundant at this station.

Chrysopsis pinifolia Ell. MOORE COUNTY: sandy place, Sept. 6, 1941, Schallert (in Herb. N. Y. Bot. Gard. as *C. aspera*); very abundant in sandhills old fields near Manly, September 15, 1949, *Godfrey* 50115.

This distinctive plant, reported for the state for the first time by Fox and Godfrey (1949), was found to be a dominant perennial in the sandhills old fields over an extensive area in and around Southern Pines and Pinehurst. There it so completely fills its ecological niche that one wondered the reason for its not having been seen, collected, and reported before. It was, therefore, a pleasure to find the Schallert specimen tucked away in the folder of *Chrysopsis aspera* at the New York Botanical Garden.

Chrysopsis trichophylla Nutt. BLADEN COUNTY: dry sandy turkey oak community, south side of White Lake, October 2, 1937, *Oosting* 1623 (in Herb. Duke Univ.); coarse white sand, scrub oak and long leaf pine sandridge, just northwest of White Lake, near the Prison Camp, July 9, 1949, *Godfrey and Fox* 49499.

Croom and Loomis (1833) included this plant in their New Bern Catalogue, and Wood & McCarthy (1886) listed it in the Wilmington flora. Curtis (1867) listed it for the Low Districts. Small (1933), however, ascribed to it the range ". . . . Fla. to S. C. and Miss., (La.?)."

Solidago flexicaulis L. MACON COUNTY: Highlands, Sept. 1902, *Harbison* (in Gray Herb.).

Included here because it is not in the checklist for the Highlands region by Quarterman and Keever (1947).

Aster mirabilis T. & G. ANSON COUNTY: Creek bank, foot of shale ridge, on Lane's Creek, 1½ miles south of Rocky River, August 12, 1949, *Fox and Boyce* 2930.

From 1835 until very recently this *Aster* was known only from a fragmentary collection from Columbia, S. C. In 1947 at the A. A. A. S. Meetings in Chicago, Cronquist reported upon several modern collections of it from the type locality, but it has remained unknown from elsewhere until this collection by Fox and Boyce.

Erigeron bonariensis L. (*E. linifolius* Willd.; *Leptilon linifolium* (Willd.) Small). CARTERET COUNTY: frequent on the waterfront and in gardens and vacant lots, Morehead City, August 3, 1949, *Godfrey* 49769; NEW HANOVER COUNTY: a very abundant weed in vacant lots and weedy places, Wilmington, June 14, 1949, *Godfrey* 49343.

Fernald (Rhodora **38**: 449, 1936), in reporting this plant for southeastern Virginia, extended the range northward from South Carolina. It is here newly recorded for North Carolina.

Gnaphalium calviceps Fern. HERTFORD COUNTY: weedy area around the fertilizer factory, Meherrin River at Murfreesboro, June 9, 1949, *Godfrey and Fox* 49222; GATES COUNTY: weedy area at a boat landing, east end of Chowan River bridge, N. C. Rt. 158 northeast of Winton, June 9, 1949, *Godfrey and*

Fox 49227; CURRITUCK COUNTY: weedy area at boat landing, Panther Landing, Northwest River below Moyock, June 10, 1949, *Godfrey and Fox* 49239; NASH COUNTY: street weed, Nashville, June 9, 1949, *Godfrey and Fox* 49216; EDGECOMBE COUNTY: sandy field, 1.3 miles east of Mildred, along U. S. Rt. 64, June 12, 1949, *Godfrey and Fox* 49326; TYRRELL COUNTY: roadside grass-weed border, 6 miles east of Creswell, June 12, 1949, *Godfrey and Fox* 49313; DARE COUNTY: weedy area around ferry landing, Roanoke Island, June 12, 1949, *Godfrey and Fox* 49304; HYDE COUNTY: dry soil of pine woods along Rose Bay Creek, near Swanquarter, June 26, 1935, *Correll* 1746 (in Herb. Duke Univ.); PAMLICO COUNTY: sandy soil, clearing on Neuse River, Camp Sea Gull, Minnesot Beach, June 11, 1948, *Godfrey* 48160; ORANGE COUNTY: weed on the campus, University of North Carolina, Chapel Hill, July 4, 1949, *Godfrey* 49384; WAKE COUNTY: garden weed, Longview Gardens, Raleigh, July 3, 1949, *Godfrey* 49382; DURHAM COUNTY: abundant in flower garden on Trinity Ave. near Watts St., Durham, May 23, 1950, *Godfrey* 50392; CUMBERLAND COUNTY: roadside grass-weed border, 5 miles south of Fayetteville along U. S. Rt. 301, July 8, 1949, *Godfrey and Fox* 49468; BLADEN COUNTY: sandy fallow field near Page's Lake, June 13, 1949, *Godfrey* 49334; BRUNSWICK COUNTY: abundant in sandy soil at roadside and edge of marsh, Brunswick River, on U. S. Rt. 17, May 21, 1949, *Godfrey* 49179.

Described from southeastern Virginia by Prof. Fernald (Rhodora **37**: 449–450, 1935), and subsequently found to be widespread in that area. This plant was first recorded for North Carolina by its inclusion in the catalogue of Wake, Durham, and Orange County composites (Godfrey, 1949). The citations above give some indication of its almost ubiquitous occurrence in the eastern part of the State.

Gnaphalium chilense Spreng. MARTIN COUNTY: old field, just above the paper mill, northeast of Plymouth, June 12, 1949, *Godfrey and Fox* 49323; DARE COUNTY: at base of Kill Devil Hill, July 3, 1939, *O. M. Freeman* (in U. S. Nat. Herb.); sand flats behind beach dunes, 2 miles north of Kitty Hawk Beach, June 10, 1949, *Godfrey and Fox* 49265; PAMLICO COUNTY: abundant in sandy old fields at Arapahoe, July 13, 1949, *Godfrey* 48322; CRAVEN COUNTY: 2 miles south of James City, *L. F. and F. R. Randolph* 550 (in Herb. Gray); ONSLOW COUNTY: very abundant in an old field, 2 miles south of Jacksonville on U. S. Rt. 17, June 21, 1948, *Godfrey* 48201; JONES COUNTY: wet sandy soil at Trenton, July 11, 1938, *Robert Gray* (in Herb. Duke Univ.); HOKE COUNTY: sandy old field, 1.5 miles south of the Moore County line, along U. S. Rt. 15 north of Laurinburg, June 27, 1949, *Godfrey and Fox* 49375; BLADEN COUNTY: sandy clearing, north shore of White Lake, July 9, 1949, *Godfrey and Fox* 49494.

Fox and Godfrey (1949) reported *Anaphalis margaritacea* (L.) B. & H. for the coastal plain of North Carolina. It was, however, *Gnaphalium chilense* Spreng. which I had misidentified as *A. margaritacea* and which it somewhat superficially resembles, and I am indebted to Prof. L. H. Shinners for the correction.* I am citing those stations again under the correct name, together

* By private communication.

with several additional ones found later. Insofar as I know, the species has not heretofore been recorded for the range of Small's Manual.

Gnaphalium peregrinum Fern. (*G. spathulatum* Lam. of authors) NASH COUNTY: street weed, Nashville, June 9, 1949, *Godfrey and Fox* 49215; DARE COUNTY: weedy area around ferry landing, Roanoke Island, June 12, 1949, *Godfrey and Fox* 49305; BEAUFORT COUNTY: sandy loam in an old field at Blount's Creek, April 5, 1939, *Godfrey, White and Shelbourne* 7049 (in Gray Herb.); PAMLICO COUNTY: sandy soil, clearing along Neuse River at Camp Sea Gull, Minnesot Beach, June 11, 1948, *Godfrey* 48161; ORANGE COUNTY: weed on campus, University of North Carolina, Chapel Hill, July 4, 1949, *Godfrey* 49383; WAKE COUNTY: Raleigh, June 4, 1924 (no collector's name on specimen); old field, Longview Gardens, east of Raleigh, May 9, 1948, *Godfrey* 49089; DURHAM COUNTY: abundant in a flower garden on Trinity Ave. near Watts St., Durham, May 23, 1950, *Godfrey* 50393; MOORE COUNTY: sandhills community, beside seepage bog in draw, 3 miles east of Southern Pines, April 10, 1949, *Frank W. and Sarah M. Woods*; BLADEN COUNTY: sandy fallow field near Page's Lake, June 13, 1949, *Godfrey* 49336; BRUNSWICK COUNTY: sandy loam, cultivated field, 2 miles south of Mill Creek Church, along N. C. Rt. 303, March 20, 1949, *Godfrey* 49008.

Small (1933) gives the range of this (as *G. spathulatum*) as "Fla. to Tex. (W. I.)." Blomquist and Oosting (1948) do not include it under either name for the piedmont of North Carolina. Fernald (Rhodora **45:** 479–480, 1943) gives its range as "Florida to Texas and Southern California, north, locally, to Southeastern Pennsylvania; eastern South America." The citations are given above to indicate that this is not an uncommon plant in our region.

Facelis retusa (Lam.) Sch.—Bip. (*F. apiculata* Cass.). CLEVELAND COUNTY: specimens (in Herb. N. C. State College) handed to Dr. G. K. Middleton, Dept. of Agronomy, for identification by a County Agent who took them from a field.

The range of this ruderal is given by Small (1933) as "Coastal Plain and Piedmont, Fla., Ala., and Ga."

Rudbeckia Heliopsidis T. & G. HARNETT COUNTY: peaty pocket, roadside clearing, 2 miles south of Lillington, along U. S. Rt. 15A, July 31, 1949, *Godfrey and Fox* 49757.

First report from outside eastern Alabama and western Georgia was by Prof. Fernald (Rhodora **42:** 496, 1940) for Prince George County, Virginia. This is, I think, the second.

Helianthus tomentosus Michx. HARNETT COUNTY: along the margin of a pine woodland where locally abundant, 6.5 miles north of Lillington, July 8, 1949, *Godfrey and Fox* 49433; CUMBERLAND COUNTY: dry pocosin, ½ mile southeast of Rockfish Creek, along N. C. Rt. 87, south of Fayetteville, July 26, 1949, *Godfrey and Fox* 49362; BRUNSWICK COUNTY: burned over shrub-bog, along Caswell Beach road near its junction with N. C. Rt. 130, August 20, 1948, *Godfrey* 48429.

These are coastal plain stations for a plant for which Small (1933) gives the range: "woods and hillsides, Piedmont and adjacent Blue Ridge, Ga. to Ala. and Va."

Coreopsis basalis (Dietr.) Blake (*C. Drummondii* T. & G.) BRUNSWICK COUNTY: abundantly naturalized in vacant lots, fields and roadsides in and around Southport, May 21, 1949, *Godfrey* 49167.

Small (1933) indicates that this plant has escaped from cultivation eastward of its natural range which is in "dry soil, and sandy prairies, Texas." Its occurrence as a volunteer in and around Southport is so extensive that at the time it blooms the many "unkempt" yards, vacant lots, and streets in the little town, and many roadsides and fields round about, are imparted a gaiety that is one of the well known charms of the place. It seems worthwhile, therefore, now to recognize the plant as a part of the flora.

Bidens pilosa L. NEW HANOVER COUNTY: sandy roadside, October 15, 1935, *P. O. Schallert* (in Herb. Duke Univ.).

An extension of range northward from southern Georgia.

Bidens polylepis Blake. (*B. involucrata* (Nutt.) Britton) SURRY COUNTY: abundant on dry old field slope, 4 miles east of Low Gap, September 6, 1949, *Godfrey and Fox* 50193; WAKE COUNTY: abundant in a moist grassy field, south of Garner, August 24, 1949, *Godfrey and Beaman* 50027; BRUNSWICK COUNTY: abundant in grass-weed border along roadside, River Road near Clarendon Plantation, August 25, 1949, *Godfrey and Beaman* 50041.

An extension of range southward from Virginia for which it was reported by Fernald (Rhodora **42**: 498, 1940).

Gaillardia lanceolata Michx. CUMBERLAND COUNTY: long-leaf pine, turkey oak sandhills, 5 miles south of Fayetteville, along U. S. Rt. 301, July 8, 1949, *Godfrey and Fox* 49455.

Biddulph (1944) gives the following distribution for this plant: "Longleaf, loblolly and slash pine forests of Florida, Georgia, Alabama, Louisiana, and Mississippi; . . ." The northeastern-most specimens she cites are from the sandhills region of South Carolina.—At our station the numerous specimens were all rayless.

Artemisia vulgaris L. WAKE COUNTY: abundant in a weedy vacant lot on South East St. in Raleigh, September 19, 1949, *Godfrey* 50067.

Too late to include it in the catalogue of Wake, Durham, and Orange County composites (Godfrey, 1949), I discovered that this wormwood is not uncommon in the vacant lots of certain parts of Raleigh. There were no specimens of it from this vicinity in the local herbaria.

Carduus acanthoides L. WATAUGA COUNTY: abundant locally in pastures and along roadside, north of Boone about 2 miles from the county line, Sept. 7, 1949, *Godfrey and Fox* 50253; BUNCOMBE COUNTY: Swiss dairy pastures, Asheville, Aug. 19, 1900, *C. Mohr* (in U. S. Nat. Herb.).

An adventive not previously recorded for North Carolina and the range of Small's Manual (1933).

Cirsium carolinianum (Walt.) Fern. & Schubert. (*C. flaccidum* (Small) Petrak) HENDERSON COUNTY: Flat Rock, July 22, 1898, *Biltmore Herbarium* 2014f (in U. S. Nat. Herb.); WAKE COUNTY: dry, open pine woodland and adjoining roadside bank, about 2 miles southeast of Raleigh-Durham airport, May 21, 1950, *Godfrey and Fox* 50388.

Fernald (Rhodora **45**: 509–510, 1943) indicates his doubtfulness as to whether this taxon occurs in North Carolina, although in Gray's Manual (1950) he gives North Carolina as the northeasternmost part of the range.

Cirsium Smallii Britton. NEW HANOVER COUNTY: frequent, sandy waysides, Wrightsville, June 22, 1950, *Godfrey* 50400.

An extension of range northward from South Carolina.

Centaurea maculosa Lam. ASHE COUNTY: West Jefferson, July 3, 1942, *Leroy R. Miller;* West Jefferson, September 10, 1944, *J. T. McLaurin;* ALLEGHANY COUNTY: grass-weed border on the road shoulder, Blue Ridge Parkway, 2 miles south of Wild Cat Rock, October 3, 1948, *Godfrey and Fox* 48638; WATAUGA COUNTY: Boone, July 26, 1932, *Blomquist* 5114 (in Herb. Duke Univ.); street weed in Boone, September 8, 1949, *Godfrey and Fox* 50257; YANCEY COUNTY: dry open soil along road, Harvard-Celo, August 11, 1935, *Correll* 3867 (in Herb. Duke Univ.); FORSYTH COUNTY: roadside, Ardmore, Winston-Salem, June 30, 1934, *P. O. Schallert* (in Herb. U. N. C.); roadside, on U. S. Rt. 421, 5 miles east of Winston-Salem, July 5, 1949, *Fox* 2514; MADISON COUNTY: Marshall, June 26, 1946, *J. E. Walker;* BUNCOMBE COUNTY: open roadside, Leicester, July 4, 1938, *Quarterman* 65 (in Herb. Duke Univ.); with no county indicated: found on road between Asheville and Blowing Rock, August 1929, *W. C. Coker*—with note on label, "Britton and Brown report it from Mass. to N. J. and Penn. . . . new to N. C.;" HAYWOOD COUNTY: Lake Junaluska, July 18, 1931, *Blomquist* 5113 (in Herb. Duke Univ.); JACKSON COUNTY: Pisgah Forest, July 25, 1940, *Helen Myers* (in Herb. U. N. C.); TRANSYLVANIA COUNTY: Pisgah Forest, on U. S. Rt. 64, July 25, 1940, *Helen Myers* (in Herb. U. N. C.); HENDERSON COUNTY: Camp Carlyle, Hendersonville, July 8, 1940, *Helen Myers* (in Herb. U. N. C.).

This adventive, now widely distributed in western North Carolina, is included in neither Small (1933) nor Blomquist and Oosting (1948). The Forsyth County records are the only ones, however, which would justify its inclusion in the latter. Jennison (Rhodora **37**: 309–323, 1935) reported it for a single locality in Tennessee.

Crepis capillaris (L.) Wallr. ASHE COUNTY: 3 miles north of Lansing, roadside, July 2, 1949, *Fox* 2467; YANCEY COUNTY: roadside, Burnsville, July 1928, *O. M. Freeman* (in Herb. Nat. Arb.); HAYWOOD COUNTY: moist, open pasture, Lake Junaluska, southwest shore, opposite golf course, June 28, 1938, *Quarterman* 46 (in Herb. Duke Univ.); roadside, Mt. Sterling, July 5, 1938, *Hall* 62 (in Herb. Duke Univ.); JACKSON COUNTY: yard, open shade, base of Wesner Bald, July 4, 1936, *Clabough* 318 (in Herb. Duke Univ.); TRANSYLVANIA COUNTY: road shoulder and pasture, on U. S. Rt. 64, 1 mi. west of Penrose, July 13, 1950, *Fox* 3984; MACON COUNTY: road shoulder and clearing, 1 mi. west of Wallace Gap on U. S. Rt. 64, July 13, 1950, *Fox* 4013.

Previously unreported for North Carolina, this species was first recorded for the range of Small's Manual (1933) by Jennison (Rhodora **37**: 309–323, 1935) for Tennessee.

Hieracium aurantiacum L. SWAIN COUNTY: moist ground among rocks, edge

of stream, north side of Soco Bald, July 12, 1937, *Blomquist* 9763 (in Herb. Duke Univ.); HAYWOOD COUNTY: Bunche's Bald, July 7, 1935, *B. W. Wells.*

First report for North Carolina and the range of Small's Manual (1933).

Hieracium pilosella L. ASHE COUNTY: moist open grassy soil on summit of Johnson's Knob, Big Tree Mt., May 26, 1939, *Correll and McDowell* 10885 (in Herb. Duke Univ.); ALLEGHANY COUNTY: near Twin Oaks, moist grassy mountain slope, May 26, 1939, *Correll and McDowell* 10815 (in Herb. Duke Univ.).

First published report for North Carolina and the Small's Manual range was by Godfrey (1949); it was based on one collection from Wake County.

Hieracium pratense Tausch. ASHE COUNTY: roadside near Watauga Co. line, June 15, 1938, *Totten* (in Herb. U. N. C.); ASHE-WILKES COUNTY LINE: roadside clearing, on Blue Ridge Parkway at Horse Gap, near N. C. Rt. 16, July 2, 1949, *Fox* 2455; SURRY COUNTY: open dry soil, Little Flat Rock, just east of Mt. Airy, May 25, 1939, *Correll and McDowell* 10740; STOKES COUNTY: near edge of Hanging Rock Park Lake, earthen dam, about 4 miles west of Danbury June 1, 1940, *Radford and Stewart* 477; WATAUGA COUNTY: roadside, between Blowing Rock and Boone, June 16, 1937, *Coker* (in Herb. U. N. C.); FORSYTH COUNTY: Winston-Salem, June 19, 1935, *Schallert* 8727; MITCHELL COUNTY: dry woods, Roan Mt., June 30, 1927, *Schallert* 8250 (in Herb. Duke Univ.); summit of Roan Mt., July 17, 1932, *Blomquist* 5230 (in Herb. Duke Univ.); Roan Mt., alt. 5500 ft., taking hold of fields and pastures here and all the way down to Blowing Rock, June 15, 1937, *Coker* (in Herb. U. N. C.); CALDWELL COUNTY: abundant on a steep bank at roadside, 2 miles from the Watauga Co. line, northwest of Lenoir, Sept. 8, 1949, *Godfrey and Fox* 50275; ALEXANDER COUNTY: Open woods on north side of Rocky Face Mountain, Hiddenite, May 29, 1941, *Keever* 330 (in Herb. Duke Univ.); YANCEY COUNTY: oak-shrub assoc., Newdale olivine deposit, 1¾ miles east of Micaville, Sept. 6, 1946, *Radford* (in Herb. U. N. C.); HAYWOOD COUNTY: Lake Junaluska, June 13, 1980, *Blomquist* 5235 (in Herb. Duke Univ.); HAYWOOD-BUNCOMBE COUNTY LINE: pastured area surrounding olivine deposit, Newfound Gap olivine deposit, 15 miles west of Asheville, May 28, 1947, *Radford* (in Herb. U. N. C.); MACON COUNTY: roadside, well drained, 4.8 miles from Highlands toward Cashiers, June 9, 1944, *Quarterman* 852 (in Herb. Duke Univ.).

Although not in Small (1933), Quarterman and Keever (1947) have this species in their summer check list of Highlands plants, and Blomquist and Oosting (1948) list it (as rare) for the piedmont, North Carolina. These citations indicate that it is widespread in the North Carolina Mountains.

LITERATURE CITED

BIDDULPH, S. F. 1944. A Revision of the Genus Gaillardia. Research Studies of the State College of Washington **12**: 195–256.

BLOMQUIST, H. L., AND H. J. OOSTING. 1948. A Guide to the Spring and Early Summer Flora of the Piedmont, North Carolina. Fourth Rev. Edition.

CROOM, H. B. 1837. A Catalogue of Plants, Native and Naturalized in the Vicinity of New Bern, North Carolina; with Remarks and Synonyms. G. P. Scott and Co., Printers. New York.

CROOM, H. B. AND H. LOOMIS. 1833. Catalogue of Plants Observed in the Neighborhood of New Bern, North Carolina. Spectator Office, New Bern.

CURTIS, M. A. 1834. A Catalogue of Plants Growing Spontaneously Around Wilmington, North Carolina, with Remarks on New and Obscure Species. Boston Jour. Nat. Hist. **1**: 82–141.

———. 1867. Botany; Containing a Catalogue of the Indigenous and Naturalized Plants of the State. Geol. and Nat. Hist. Surv. of N. C., Part III. Raleigh.

CRONQUIST, ARTHUR. 1947. The Biotian Asters of the Southern Piedmont. Abstract. Am. Jour. Bot. **34**: 28a.

FERNALD, M. L. 1950. Gray's Manual of Botany, Eighth Edition. American Book Company, New York.

FOX, WILLIAM B., AND R. K. GODFREY. 1949. Notes on the Distribution of North Carolina Plants—I. Rhodora **51**: 129–146.

GODFREY, R. K. 1948. Studies in the Compositae of North Carolina I. *Liatris*. Jour. Elisha Mitch. Sci. Soc. **64**: 241–249.

——— 1949. Studies in the Compositae of North Carolina II. The Compositae of Wake, Durham, and Orange Counties. Jour. Elisha Mitch. Sci. Soc. **65**: 276–305.

HYAMS, M. E. 1885. A Preliminary List of Additions to Curtis' Catalogue of Indigenous and Naturalized Plants of North Carolina—Flowering Plants. Jour. Elisha Mitch. Sci. Soc. **2**: 72–76.

QUARTERMAN, ELSIE AND CATHERINE KEEVER. 1947. A Summer Check List of the Vascular Plants of the Highlands Region. The Highlands Museum and Biological Laboratory Publ. No. 6.

SHERFF, E. E. 1937. The Genus *Bidens*, Part I. Bot. Ser. Field Mus. Nat. Hist. **16**.

SMALL, J. K. 1933. Manual of the Southeastern Flora. Publ. by the Author. New York.

WOOD, T., AND G. MCCARTHY. 1886. Wilmington Flora; a List of Plants Growing About Wilmington, N. C., with Date of Flowering, with a Map of New Hanover County. Jour. Elisha Mitch. Sci. Soc. **3**: 77–141.

THE UMBELLIFERAE OF NORTH CAROLINA AND THEIR DISTRIBUTION IN THE SOUTHEAST*

By Charles Leland Rodgers

Department of Botany, University of North Carolina
Chapel Hill, North Carolina

Plates 13–21

Introduction

Although Europeans had previously published general treatments of the Umbelliferae, it was not until 1888 that John M. Coulter and J. N. Rose did a major revisionary work on this family for North America. After acquiring a broader knowledge of the family, they published (1900) a monograph which they considered to be a more natural presentation. By that time it was generally recognized that affinities of genera and species in this group were best indicated by fruit characters, and they and subsequent authors of regional manuals continued to rely upon these characters. The Umbelliferae in North America were monographed again in 1945 by Mildred E. Mathias and Lincoln Constance, who produced a very usable manual rich in synonymy.

In the South, Thomas Walter's scholarly classic, *Flora Caroliniana*, appearing exactly one hundred years before Coulter and Rose's monograph, was the first of a series of general floras of this region. In fact, this pioneering work seems to have been tremendously important in stimulating and setting a pattern for similar endeavors elsewhere in this country. A more comprehensive two-volume flora covering South Carolina and Georgia was completed by Stephen Elliott in 1824. Later a flora of the southern states, including North and South Carolina, Georgia, Florida, Alabama, Mississippi, and Tennessee, was prepared by Dr. A. W. Chapman, a Florida physician. This book went through three editions from 1860 to 1897. This was followed in 1903 by J. K. Small's *Flora of the Southeastern United States*, covering the same territory and in addition a considerable area west of the Mississippi River. Small's more recent *Manual of the Southeastern Flora* (1933) is limited to the area east of the Mississippi, and is the most complete work on this region.

No previous attempt has been made to treat comprehensively the Umbelliferae of North Carolina. A number of earlier local and out-of-state botanists have collected specimens and published their observations. In North Carolina, the most active botanists before 1900 were Croom, Loomis, Curtis, de Schweinitz, McCarthy, Wood, and Hyams. H. B. Croom and H. Loomis compiled (1833) a list of plants found in the New Bern area at approximately the same time the

* A thesis submitted to the Faculty of the University of North Carolina in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Botany. The author's present address is Route 1, Taylors, S. C.

Rev. Moses A. Curtis was cataloguing them for Wilmington and the Rev. L. D. de Schweinitz was actively studying them around Winston-Salem. Four years later Croom expanded his earlier work; and still later (1867) Curtis completed a catalogue of plants for the entire state. Additions to Curtis' catalogue were made by M. E. Hyams eighteen years later. Curtis' earlier flora of the Wilmington region was followed in 1886 by a Wilmington flora done jointly by Thomas F. Wood and Gerald McCarthy. His state flora was also followed by C. W. Hyams' *Flora of North Carolina* in 1899.

After 1900, published reports including references to Umbelliferae are chiefly of the nature of local floras or ecological studies. While it is impossible in some cases to tell precisely in what county a plant was observed, they do help to give an over-all picture of distribution. The following reports are some of the more useful for the present study: E. R. Memminger (Henderson County, 1915), I. F. Lewis (Shackleford Bank, 1918), W. L. McAtee (Church's Island, 1919), D. C. Peattie (Tryon Region, 1928–1930), B. W. Wells (Natural Gardens, 1932), Elsie Quarterman and Catherine Keever (Highlands Region, 1947), H. L. Blomquist and H. J. Oosting (Spring and Early Summer Flora of the Piedmont, 1948), A. E. Radford (Flora of Olivine Deposits, 1948), and W. B. Fox and R. K. Godfrey (Notes on Distribution, 1949).

This paper is an attempt to make the most of all available collections and published reports in conjunction with information gained from intensive field collecting during the entire growing season of 1949. This survey includes collections from every county of North Carolina and from every type of habitat. Since North Carolina is only a cross-section of three large physiographic regions, —mountains, piedmont, and coastal plain,—it seems best to include in this consideration all North Carolina species throughout their entire range. However, distributional data are recorded only for the Southeast, corresponding to the area of Small's *Manual*. Specimens studied from all states except North Carolina were from herbaria.

This study is not an attempt at revisionary work, the nomenclature being almost exclusively that of Mathias and Constance in *North American Flora*. The order of genera varies a little from the usual presentation to be consistent with some suggestions of affinity which are to follow later. The descriptions are for the most part from actual observations except in some cases of maximum size measurements. Unless an obvious error was indicated, the largest measurements recorded are usually used here.

A tabulation of all the records examined indicates that 34 genera, 59 species, and 4 varieties of Umbelliferae actually grow or have grown in North Carolina. Of this total, 44 species and 2 varieties are native, and 15 species and 2 varieties are introduced. The presence of one or two species is doubtful, and additional introductions in the future are probable. With this in mind, both the doubtful species and the most likely introductions are included in the keys.

ECONOMIC IMPORTANCE

Some of the Umbelliferae have been of considerable economic importance for a long time. Their uses are varied, some being used for foods, flavoring, or medi-

cines. Others have a negative value in that they are deadly poisonous to human beings or livestock when eaten by mistake, and a few are distinct nuisances as weeds. Of all the Umbelliferae in North Carolina, Queen Anne's Lace is definitely the most annoying and widespread weed, though on the other hand it is widely used for decorative purposes. Water Hemlock (*Cicuta*) grows in all sections of the state in bottom land. It is said to be deadly poisonous, especially the roots. Poison Hemlock (*Conium*), an uncommon introduction, is another deadly poisonous species. Although the fruits are most dangerous, it should never be grown where children might be tempted to chew it or to make blow-pipes from its hollow stems.

The members of this family still recognized in the *United States Pharmacopoeia* or the *National Formulary*, or in both, are Anise, Asafetida, Caraway, Coriander, Fennel, and Parsley.

TAXONOMIC CRITERIA

For a long time fruit characters have been used as the best indicators of relationships in the Umbelliferae. Other characters were thought to be either too uniform or too variable to be of much help except in a limited sense. The following evaluation of characters will show why some are more usable than others.

Roots. In spite of the numerous modifications to which roots are subjected, some characters are predictable under average conditions. A few examples are toproots in *Daucus*, club-shaped or obovate tuberous roots in *Oxypolis ternata*, fleshy-fibrous roots in *Sanicula smallii*, and black roots in *Sanicula marilandica* and *S. gregaria*.

Leaves and *stems* are often so variable within a genus or species that they are of little use in considering relationships. Conversely, they are so similar in some different genera that it is difficult or impossible to distinguish them without flowers or fruits. Such a difficulty is encountered in *Spermolepis divaricata* and *Apium leptophyllum* or in *Thaspium trifoliatum* and *Zizia aptera*. Leaves are often influenced to a considerable degree by environmental conditions. *Oxypolis rigidior* demonstrates nicely the extent of variation possible. However, leaf differences are very useful in separating species in the genus *Oxypolis*.

Inflorescences. All of the species of *Hydrocotyle* in this region can be distinguished by obvious differences in their manner of floral display. Likewise, *Torilis nodosa* and *T. japonica* can be so distinguished. Yet there are many genera which have similar inflorescences. Bentham and Hooker laid great stress on whether the umbels were simple or compound. Actually they may vary on a single plant, as in *Chaerophyllum tainturieri* and *Scandix pecten-veneris*. Sometimes it is difficult to tell whether they are simple or compound, as indicated by interpretations placed on the inflorescences of *Sanicula*. Coulter and Rose, Britton and Brown, Gray, Small, and Mathias and Constance describe the umbels as being irregularly compound and few-rayed. Actually, the "umbelets" are homologous to the heads of *Eryngium* and should be considered simple umbels. Just as in *Eryngium*, they are cymosely arranged. When examined with this in mind, the "irregular compound few-rayed" umbels no longer appear irregular or few-rayed but conform to a regular cymose pattern.

Typically, *Sanicula*'s simple stalked umbels are subtended by one to several, usually 2–4, branches longer than the peduncles and bearing a stalked umbel subtended by branches. This branching or compounding continues until the branches subtending the terminal umbels fail to develop, and may occur four or five times before it stops. This type of branching is interesting in terms of the usual display of inflorescences in Umbelliferae where they nearly always, if not always, occur opposite the leaves (sometimes obscure if leaves are extremely reduced). This arrangement is interpreted as terminal. By shortening one or more internodes so that the nodes are brought together, the cymose pattern of floral display can be produced. All degrees of shortening of the internodes have been observed between the normal length and a whorled condition with one terminal inflorescence and several whorled (axillary) branches.

Bracts. The variability in shape and number of bracts minimize their usefulness as diagnostic characters in many genera and species. Extremes in irregularity are encountered in *Ptilimnium costatum* where the bracts are simple to pinnate. On the other hand, they are constantly absent in some species and always present and highly uniform in others.

Bractlets, generally present in compound umbels, are monotonously simple and less useful than bracts.

Calyx-teeth are usually absent or uniform and small. Best use of these characters is made in the genera *Sanicula* and *Eryngium*, where they are well developed and persistent in the fruits.

Petals and other floral parts have never been used extensively for the probable reason that they are small, fairly uniform, and relatively short-lived. Although the petals are generally much alike, some differences in shape, presence or absence of pubescence, or color are distinct enough for use. Perhaps the tendency to zygomorphy and the nature of petal tips are even more significant.

Contrary to the usual pattern in Umbelliferae, *Hydrocotyle* and *Centella* have straight petals or at the most concave, certainly not recurved at the tip. This is occasionally true of some genera and species in another subfamily. Besides the tip character, petals may be erect or spreading at maturity. Apparently this is a characteristic of genera or larger categories. The usefulness of such a character is limited because of the uncertainty of knowing whether the flowers are completely mature or not.

Stamens are too ephemeral and uniform to attract much attention. The major variations not to be overlooked are color and length as compared to the petals.

Styles are like the stamens in being variously colored and included or exserted They offer considerable difficulty at times in determining their length due to the uncertainty of knowing whether or not they have reached their maximum development.

Stylopodium or *disk*.—Whatever the true nature of these glandular structures, they are major taxonomic features. Their size, shape, lobation, and relation to the styles are distinctive. If the style projects from the top, the structure is called a stylopodium; and if the style is separate and surrounded by it, the structure is called a disk. As the name implies, the stylopodium is usually con-

sidered to be the foot of the style. It could be that the style is simply fused with the disk.

Fruits.—Completely mature fruits provide the characters which seem to indicate relationships best. The differences in wall structures, ribs, oil-tubes, carpophores, shapes, and directions of flattening afford the major bases for separating subfamilies, tribes, genera, and to a lesser degree species.

The walls of the pericarp in most Umbelliferae have strengthening cells located in the ribs or endocarp. A majority of species have primary ribs only, but several have secondary ribs, some of which are more prominent than the primary ones. Ribs may be obscure, in which case the walls are often covered with bristles or scales. Oil-tubes are usually between the primary ribs and on the commissure. Noticeable variants from that pattern are *Sanicula* and *Eryngium* in which oil-tubes are located in the primary areas and *Hydrocotyle* in which they are usually absent. The carpophore is distinct in most members of one subfamily. Its chief variation is in the extent of longitudinal splitting.

One of the most obvious differences in fruits is the direction of flattening. *Hydrocotyle* and *Centella* have fruits extremely flattened at right angles to the line where the carpels fuse (lateral); and *Pastinaca* and *Heracleum* have fruits flattened parallel to the line of fusion (dorsal). The flattening is effected at various times in the development of the different species. In *Hydrocotyle*, lateral flattening of the ovary is evident in very young buds, yet the ovaries are not as extremely flattened as the fruits. In *Pastinaca sativa* and *Angelica triquinata* the ovaries in the buds are actually laterally flattened while the fruits are dorsally flattened. In *Angelica venenosa* dorsal flattening is later, the ovaries of flowers being somewhat laterally flattened. A further delay in dorsal flattening is in *Oxypolis rigidior*, *O. ternata*, and *O. filiformis* where the ovaries of buds and flowers are distinctly laterally flattened and where fruits mature distinctly dorsally flattened.

Seeds have several useful characters when they are thoroughly mature. Their commissural faces may be deeply grooved, concave, or plane; they may or may not be grooved under the oil-tubes. Internally, they vary in degree of oiliness. Seed characters are more difficult to use since they require sectioning of fruits.

Chromosomes have been counted in only a few cases, chiefly in cultivated and European species. Only two or three species native to the Southeast have been examined. A summary of all counts indicates that the chromosome numbers are almost constant in the subfamilies (Wanscher, 1934).

INTERRELATIONSHIPS

Any conclusions about relationships drawn from knowing many species over an extensive geographical area would be better than decisions based on any less comprehensive knowledge. Although recognizing that there are limitations to making extensive conclusions, it is believed that sufficient information is at hand to warrant a discussion of affinities in some cases, particularly where the group is well represented in this area.

A look at the differences in Bentham and Hooker's and Drude's (in *Pflanzen-*

familien) attempts to produce a natural system of classification for the Umbelliferae shows the uncertainty of what characters should be given most weight in determining relationships. Both recognize three series or subfamilies based on different characters.

Bentham and Hooker's series Heterosciadiae (including *Hydrocotyle*, *Sanicula*, and *Eryngium*) usually has simple umbels and no oil-tubes at or near the depressions; series Haplozygiae has compound umbels, only primary ribs of fruit conspicuous, and usually oil-tubes at or near the depressions; and series Diplozygeae has compound umbels and depressions over the oil-tubes thickened or drawn-up into secondary ridges (ribs). They considered the nature of the umbels and oil-tubes of primary importance.

Drude's subfamily Hydrocotyloideae (including *Hydrocotyle*) has fruits with woody endocarps, no free carpophores, and oil-tubes absent or sunk in the main ribs only; and subfamily Saniculoideae (including *Sanicula* and *Eryngium*) has soft parenchymatous endocarps, exocarps usually with appendages, styles surrounded by disks, and oil-tubes various. These two subfamilies correspond to Bentham and Hooker's series Heterosciadiae. His third subfamily, Apioideae, has soft parenchymatous endocarps (sometimes with subepidermal layers of wood fibers), styles on apexes of disks, and oil-tubes various. This subfamily includes a group with secondary ribs which corresponds to Bentham and Hooker's series Diplozygeae.

A comparison of the two systems indicates that the sequence is similar, but that lines are drawn at different places. Considering the sum of all characters, it seems that the system of Drude is better. It is based on a shift of emphasis from the nature of the inflorescence to the nature of the fruit.

Subfamily Hydrocotyloideae is represented here by *Hydrocotyle* and *Centella*. There is no doubt that they are close. Besides the characteristics already listed, they have extremely laterally flattened fruits (Figs. 1 & 2), straight and spreading petals, stamens about length of petals, stamens and pistils maturing at about the same time, depressed stylopodia, simple leaves, and creeping stems. Several of these characters are not common outside of this group.

The stony endocarp of members of this group is not solely confined to it. Both *Heracleum* and *Pastinaca* (Figs. 32 & 33), equally strongly flattened in the opposite direction, are similarly equipped. To avoid leaving the impression that extreme flattening is always associated with a stony endocarp, it should be pointed out that a stony endocarp is known in some genera with little or no flattening while some with considerable flattening do not have a stony endocarp.

Subfamily Saniculoideae is represented here by *Sanicula* and *Eryngium*. They are indeed close as indicated by their similar displays of flowers, ornamented fruits, primary oil-tubes, circular disks around base of styles, long and persistent calyx-teeth, erect and recurved petals, and usually long-exserted styles and stamens. Several of these are worthy of discussion for clarification or because of their uniqueness.

The arrangement of the oil-tubes in the primary areas is unusual. Even the two large oil-tubes on the commissure are more widely spaced than is commonly

true of other Umbelliferae thereby placing them in the general positions of the lateral primary areas. This pattern holds true in all North Carolina representatives of the subfamily except in *Sanicula trifoliata*. It often has two large oil tubes marking the lateral primary regions, but the other three large ones are absent. In some species of *Sanicula* from other parts of the world, the tubes are often smaller and irregularly arranged.

The fruits of some species of *Sanicula* are pedicellate (Fig. 4), and strangely enough, these stalks split to their bases into two parts when the mericarps do. Unlike the pedicels of other Umbelliferae, they remain attached to the fruits when they shed, and their inner faces are continuous. This unusual condition suggests the possibility that the pedicels are really the contracted bases of the fruits. If this be the case, all fruits of *Sanicula* would be sessile just as they are in *Eryngium*.

Subfamily Apioideae contains the vast majority of genera and species. Hardly any single character is consistent throughout the group, yet their over-all appearance and similar structures indicate that they should be together. They usually have stylopodia, carpophores, primary ribs, and oil-tubes between the ribs. Probably the greatest variation from the majority is in *Daucus* and *Torilis*.

The lumping together of all species with extreme dorsal flattening does not seem to reflect their true origins. Some members have little in common except extreme flattening. It is more likely that this tendency had several origins. For example, the lateral wings of *Oxypolis* (Fig. 29) are not extensions of lateral ribs as appear to be the case in *Heracleum* and *Pastinaca*. The ribs are obviously dorsal to the wings (ribs usually described in the literature as nerved on the dorsal face). This new interpretation is based on the idea that strengthening cells are directly under true ribs and would hardly be expected off to the side. Certainly that is the position occupied in most, if not all, Umbelliferae. The distinctness of ribs and wings can be seen easily in sections of green fruits.

A possible clue of affinity should be sought elsewhere. It might be found in *Ptilimnium* or *Lilaeopsis*, for example. It is easy to visualize the cork cells between the two lateral ribs of some species of these genera proliferating into the lateral wings of *Oxypolis* since they occupy the same relative positions. The corky bands have been considered to be parts of the lateral ribs, but their position relative to the vascular traces and strengthening cells is usually distinctly toward the commissure (Figs. 27 & 28). For that reason, they are treated here as two distinct structures in the same way that the wings and ribs are treated in *Oxypolis*. They are regularly separate and uniform in *Ptilimnium capillaceum* and more irregularly separate and less uniform in *Lilaeopsis*. This fruit character is not the only point of similarity between *Oxypolis* and *Lilaeopsis*, for both genera have highly specialized representatives with phyllodes. On the other hand, striking differences may mean that these similarities are parallel developments.

Taenidia, *Thaspium*, and *Zizia* are closely linked by a combination of many similar features. They have regular flowers with yellow (one exception), erect, recurved petals and have fruits built on a similar plan. The apexes of the ovaries bear disks closely associated with the styles. Fruits in all three genera usually

have small oil-tubes outside the strengthening tissue in the ribs in addition to the regular larger ones. However, this characteristic is not wholly confined to these genera.

No less important is a consideration of the geographical distribution of these genera. When mapped, they all occupy regions overlapping in the eastern part of the United States. This is highly suggestive of a common line of origin somewhere in that area.

Pseudotaenidia appears to be close to this group, but because of a scarcity of material, a careful study was not possible. A striking point of difference from *Taenidia* is its dorsally flattened fruits. By taking the position that flattening arose in several places and at different times, it is easier to place it with *Taenidia* with which there is a striking resemblance. These two monotypic genera should be studied more carefully to confirm or deny this suggestion.

Another possible evidence for its being derived from *Taenidia* may be found in their geographical distributions. *Taenidia* ranges from Georgia to Texas and north to Quebec and Minnesota. The known range of *Pseudotaenidia* is from Virginia and West Virginia to Maryland and Pennsylvania. There is no known evidence that one is more fitted for survival than the other. It seems more likely that *Taenidia* is older and that *Pseudotaenidia* is younger and derived from it.

TAXONOMIC TREATMENT

Several terms need defining in order to interpret correctly what is to follow in the descriptions. The ovary, although inferior, is used here to describe the immature structure of the flower which will become the fruit. Petal length is the distance from the base to its outermost extent, either the tips or to where it recurves. When leaves are described as opposite the umbels, they may be normal or reduced, even bract-like.

Primary or secondary when used to describe a mericarp structure refers to its location. There are five primary and four secondary positions. Primary positions are on each side at the margin of the commissure (lateral), in the middle opposite the commissure (dorsal), and between the margins and the middle (intermediate). Secondary positions are between the primary ones.

Only one specimen from a county is cited and mapped. The word "county" and most given names or initials of collectors are omitted; either the collector's number or the date of the collection follows the name of the collector. Where several specimens are known from the same county, those at the University of North Carolina, Duke University, and North Carolina State College are given preference in that order. In other cases, specimens are generally cited which are duplicated in several herbaria. Personal collections from North Carolina have been deposited in the herbarium of the University of North Carolina; some duplicates elsewhere.

The maps usually have the largest number of symbols in North Carolina; in the majority of cases this indicates more intensive collecting rather than a greater density of population. If symbols on maps cannot be placed exactly where they should be, an arrow will indicate the direction from which they are displaced.

All range extensions beyond that given by Small or Mathias and Constance are indicated by the inclusion of the collector's name and number or date of collection in parenthesis following the location. This information is given in the treatment of each individual species under the discussion of distribution.

If any name differs from that found in Small's Manual, his name is listed as a synonym. Otherwise, synonyms are limited to a few well known ones. For a more complete listing of synonyms, refer to Mathias and Constance's monograph in *North American Flora* (1944–1945).

The symbols representing herbaria where cited specimens are deposited are as follows:

CLEMS	Clemson College
DUKE	Duke University
FLA	University of Florida
FUR	Furman University
GA	University of Georgia
GH	Gray Herbarium, Harvard
NCS	North Carolina State College
NCU	University of North Carolina
NY	New York Botanical Garden
PH	Philadelphia Academy of Natural Sciences
TENN	University of Tennessee
US	United States National Herbarium

FAMILY UMBELLIFERAE

Plants predominantly herbaceous. Stems erect or creeping, often hollow between the nodes. Leaves usually simple to decompound, sheathing at the base, and alternate. Inflorescences of umbels, heads, or proliferating umbels (flowers verticillate on axes). Flowers regular or somewhat radiant, mostly perfect or andromonoecious, and pentamerous except for bicarpellate pistil. Calyx-teeth absent to long and persistent, usually small. Petals erect or spreading, straight or recurved at the tips. Stamens alternate with petals; anthers versatile. Styles arising from the top of a glandular structure (stylopodium) or encircled by a glandular disk at their base. Ovary inferior, two-chambered; each chamber with a single anatropous ovule. Fruit a schizocarp with two parts (mericarps) and terete to extremely flattened (dorsally, if parallel to plane of commissure; laterally, if at right angles to plane of commissure). Mericarps usually with five primary ribs or wings and sometimes with four secondary ones; mericarps may be covered with bristles or scales, and ribs may be obscure. Carpophore present or absent, entire to split to base. Oil-tubes usually present in pericarp, especially between ribs. Seed smooth or furrowed, endosperm abundant, embryo small.

Although cosmopolitan, the Umbelliferae are most abundant in north temperate regions and scarce in the tropics except in the mountains. The name Umbelliferae was first applied to this family by A. L. de Jussieu in *Genera Plantarum* in 1789. Willis (1948) estimates that there are two hundred genera and twenty seven hundred species in the family.

KEY TO THE UMBELLIFERAE OF NORTH CAROLINA

1. All leaves simple 2
   Some leaves compound 9
2. Stems creeping, sometimes weakly ascending 3
   Stems erect 6
3. Leaves with blades less than five times as long as wide, rarely more, rarely entire 4
   Leaves elongate, many times longer than wide, always entire (leaves actually septate phyllodes) ..... 29. *Lilaeopsis*
4. Leaves peltate or if not peltate, bases cordate to almost truncate; petals not recurved at tips; stamens and styles about equal or shorter than petals; ovary and fruit strongly laterally flattened 5
   Leaves not peltate, bases tapering or palmately lobed or leaves pinnatifid; petals recurved at tips; stamens and styles much longer than petals; ovary and fruit slightly flattened or terete ..... 3. *Eryngium*
5. Leaf blades ovate to oblong; flowers or fruits in inflorescence usually 2 or 3, rarely 4, subtended by 2 conspicuous bracts ..... 2. *Centella erecta*
   Leaf blades round to reniform; flowers or fruits in inflorescence 1 to many, each subtended by a bract ..... 1. *Hydrocotyle*
6. Leaves terete (rush-like); if not terete, some perfoliate 7
   Leaves with blades, but not perfoliate 8
7. Leaves terete; flowers white; fruits dorsally flattened ..... 30. *Oxypolis*
   Leaves perfoliate or clasping; flowers yellow; fruits somewhat laterally flattened 16. *Bupleurum rotundifolium*
8. Inflorescence of heads; ovary and fruit with hyaline scales or tubercles ..... 3. *Eryngium*
   Inflorescence of umbels; ovary and fruit without scales or tubercles 30. *Oxypolis ternata*
9. Inflorescence of distinct heads or of umbels so compacted that they appear capitate (if inflorescence a compacted umbel, plants are hispid) 10
   Inflorescence of distinct umbels or if reduced and somewhat "head-like," usually containing 3 perfect flowers or fruits and 0 to many staminate flowers (if inflorescence somewhat "head-like," plants are always without pubescence) 11
10. Plants glabrous; ovaries and fruits with hyaline scales or tubercles ..... 3. *Eryngium*
    Plants hispid; outer part of ovaries and fruits with bristles ..... 6. *Torilis nodosa*
11. Ovary and fruit with pubescence, tubercles, bristles, or teeth 12
    Ovary and fruit smooth or with ribs or wings 21
12. Ovary about twice as long as wide or longer; fruit obviously over twice as long as wide 13
    Ovary less than twice as long as wide; fruit less than twice as long as wide to about twice as long as wide 14
13. Leaves with first divisions ternate; ovary and fruit narrowed at base ..... 8. *Osmorhiza*
    Leaves pinnately decompound; ovary and fruit with a beak at apex several times longer than the body ..... 7. *Scandix pecten-veneris*
14. Leaves compound, palmately 3- or 5-foliate, rarely 7-foliate 15
    Leaves decompound 16
15. Plants wooly; petioles of upper leaves conspicuously "inflated," wooly; ovary and fruit pubescent; flowers irregular ..... 33. *Heracleum lanatum*
    Plants glabrous or glaucous; petioles of upper leaves not conspicuously "inflated"; ovary and fruit with bristles; flowers regular ..... 4. *Sanicula*
16. Leaf blades broad, thickish; ovary and fruit pubescent; mature fruit strongly dorsally flattened; petioles of upper leaves "inflated" and their blades reduced or absent 31. *Angelica venenosa*
    Leaf blades dissected; ovary and fruit with teeth, tubercles, bristles, or minute pubescence; mature fruit laterally flattened or terete; petioles of upper leaves not strongly "inflated" 17

17. Plants glabrous; ovary and fruit tuberculate....18
Plants hispid to weakly pubescent, rarely glabrous; ovary and fruit with teeth, bristles, or minute pubescence....19
18. Stem spotted; plant with strong offensive odor; petals unequal, recurved at tips; all flowers and fruits pedicellate....12. *Conium maculatum*
Stem not spotted; plant without strong offensive odor; petals about equal, not recurved at tips; central flower and fruit in many umbelets sessile or short pedicellate
23. *Spermolepis divaricata*
19. Ovary and fruit with teeth or bristles; flowers, especially outside ones, somewhat or distinctly irregular; petals white, pink, or purple; fruit with bristles or teeth....20
Ovary and fruit minutely pubescent; flowers regular; petals yellow; fruit with shallow wings....18. *Thaspium pinnatifidum*
20. Bracts mostly pinnate or pinnately decompound, sometimes 3-parted or rarely simple; bractlets simple to pinnate; teeth of fruit usually much flattened, in simple rows
5. *Daucus*
Bracts absent or simple and narrow; bractlets subulate, sometimes acute; bristles of fruit glochidiate, not in simple rows....6. *Torilis japonica*
21. Lower leaf or leaves trifoliate, bifoliate, or simple; most other leaves trifoliate or simpler....22
Lower leaf or leaves with more than three blades; most other leaves trifoliate or more compound, sometimes all leaves dissected....27
22. Basal leaf or leaves simple, cordate; stem leaves usually like the basal ones or trifoliate....23
Basal leaf or leaves trifoliate or simpler, if simple, not cordate; stem leaves usually like the basal ones, but may be more compound....24
23. Perfect flowers and fruits when present in center of umbelets always sessile or subsessile; ribs of fruit filiform, not winged....19. *Zizia aptera*
All flowers or fruits on distinct pedicels; ribs of fruits winged....18. *Thaspium*
24. Plants wooly; petioles of upper stem leaves conspicuously "inflated" and wooly; flowers irregular....33. *Heracleum lanatum*
Plants glabrous or pubescent (not wooly); petioles of upper stem leaves neither "inflated" nor wooly; flowers regular or nearly so....25
25. Leaf blades long and slender (many times longer than wide); roots tuberous, club-shaped or obovoid; fruits dorsally flattened....30. *Ozypolis ternata*
Leaf blades broad; roots fibrous or fleshy, but not broadest at distal end; fruits laterally flattened or terete....26
26. Terminal leaflets tapering and serrate at base; fruit twice as long as wide or longer; umbels distinctly asymmetrical because rays (1–6) and pedicels very unequal; flowers white; all leaves trifoliate....10. *Cryptotaenia canadensis*
Terminal leaflets tapering, truncate, or cordate, but not serrate at base; fruit less than twice as long as wide; umbels symmetrical, rays 3–16; flowers yellow or purple; leaves all trifoliate or trifoliate to decompound....(go back to 23)
27. Blades of upper or all stem leaves much dissected....28
Blades of upper or all stem leaves broad, if narrow, not dissected; upper leaves may be considerably reduced....39
28. Ultimate divisions of upper leaves filiform or linear....29
Ultimate divisions of upper leaves broader....34
29. Umbels simple, 1–3 at a node or compound with 1–3 rays; some center flowers and fruits sessile or subsessile; petals not recurved at tips....24. *Apium leptophyllum*
Umbels compound, mostly over 3-rayed; center flowers and fruits of umbelets distinctly pedicellate; petals recurved at tips....30
30. Bracts and rays arising from a disk; bractlets and pedicels arising from smaller disks
25. *Ammi visnago*
Bracts absent or if present, they and rays not arising from a disk; bractlets absent or if present, they and pedicels not arising from disks....31

31. All leaves decompound; flowers regular or nearly so; ribs of fruit not wavy; fruits flattened or almost globose (if globose, mericarps separate easily), flattened fruits longer than wide and tending to split apart at maturity....32
Lower leaves simple, ternate, or pinnate and having broad blades with coarse teeth or lobes; flowers irregular; radiant petals deeply bilobed and with obvious branching veins; ribs filiform, straight ones alternate with wavy ones; fruit globose, mericarps not separating easily at maturity....11. *Coriandrum sativum*
32. Bracts and bractlets absent; flowers yellow; plant with strong anise odor; perennial 14. *Foeniculum vulgare*
Bracts and bractlets present or sometimes absent; flowers white or rarely rose-colored; plant with no odor of anise; biennial or annual....33
33. Umbels very asymmetrical, the rays and pedicels very unequal; taproots; fruits without band of cork at the commissure, more than twice as long as wide....20. *Carum carvi*
Umbels symmetrical; roots fibrous; fruits with a band of cork at the commissure, less than twice as long as wide....28. *Ptilimnium*
34. Ovary and fruit twice as long as wide or longer....9. *Chaerophyllum*
Ovary and fruit less than twice as long as wide....35
35. Plants small, less than 20 cm. tall, and arising from deep, globular tubers; petals not recurved at tips; leaves mostly 1–3 (occasionally 4); umbels with 1–4 rays; bractlets spatulate....13. *Erigenia bulbosa*
Plants larger, much more than 20 cm. tall, not arising from globular tubers; petals recurved at tips; leaves usually several to many more than four; umbels usually with well over 4 rays; bractlets not spatulate....36
36. Stem spotted; plant with strong offensive odor....12. *Conium maculatum*
Stem not spotted; plant without strong offensive odor....37
37. Petioles of upper leaves "inflated", more conspicuous than their reduced blades; petals white; some flowers irregular; fruit much dorsally flattened 32. *Conioselinum chinense*
Petioles of upper leaves not "inflated"; petals yellow; flowers regular; fruit laterally flattened or slightly dorsally flattened....38
38. Bractlets with hyaline margins; fruit laterally flattened, not winged; blades of upper leaves with narrow divisions....15. *Petroselinum*
Bractlets without hyaline margins; fruit terete or slightly flattened, winged; blades of upper leaves broad, coarsely toothed or incised....18. *Thaspium barbinode*
39. Leaves mostly pinnate (usually 7 or more leaflets; all leaflets except terminal one sessile or on short petiolules)....40
Leaves mostly pinnately or ternately decompound (upper leaves may be simpler), if pinnate, leaflets usually fewer than 7, with lower leaflets larger and stalked and those at apexes of leaves smaller and sessile....42
40. Blades of leaflets entire or with a few large teeth concentrated toward tips or along one side....30. *Ozypolis rigidior*
Blades of leaflets never entire; teeth numerous and extending almost completely around margin....41
41. Blades of leaflets coarsely and irregularly serrate, often variously cut; lower leaves never pinnately dissected; flowers yellow; fruit dorsally flattened 34. *Pastinaca sativa*
Blades of leaflets sharply and uniformly serrate; lower leaves sometimes pinnately dissected; flowers white; fruit laterally flattened....26. *Sium suave*
42. Leaflets entire....17. *Taenidia integerrima*
Leaflets not entire....43
43. Many umbels sessile or nearly so; basal leaves pinnate-ternate or bipinnate 24. *Apium graveolens*
Umbels pedunculate, rarely sessile; basal leaves variable, but not pinnate-ternate..44
44. Petioles of upper leaves "inflated", more conspicuous than their reduced blades (sometimes blades absent); fruit much dorsally flattened....45

Petioles of upper leaves not "inflated", less conspicuous than their blades; fruit laterally flattened or obscurely dorsally flattened (if dorsally flattened, some ribs are winged) 46

45. Leaves pinnate or bipinnate; leaflets obtuse to acute; flowers yellow; bractlets usually absent or if present, few ..... 34. *Pastinaca sativa*

Leaves usually 2-or 3-ternate or ternate-pinnate; leaflets usually acuminate; flowers greenish; bractlets always present (6–12) ..... 31. *Angelica triquinata*

46. Branches bearing umbels usually opposite or whorled; leaves on these branches very reduced or bract-like; umbels usually several to many and arranged in a simple or compound cyme; stem very brittle; root with the odor of celery and bearing a crown of fibers ..... 21. *Ligusticum canadense*

Branches bearing umbels usually solitary or absent, if opposite or whorled, branches usually leafy; umbels opposite leaves or cymose, if cymose, leaves on branches not bract-like; stems not unusually brittle; root neither with odor of celery nor having a fibrous crown 47

47. Perfect flowers or fruits when present in center of umbelets always sessile or subsessile 19. *Zizia*

All flowers or fruits distinctly pedicellate 48

48. Flowers white; ribs of fruit not extended as wings 49

Flowers yellow; some ribs of fruit extended as wings ..... 18. *Thaspium barbinode*

49. Leaves not variegated; veins of leaves usually ending near notches between the teeth or approaching them closely before branching toward teeth; petioles without hyaline-margined sheaths ..... 27. *Cicuta*

Leaves variegated; veins extending to teeth; petioles with hyaline-margined sheaths 22. *Aegopodium podagraria* var. *variegatum*

1. HYDROCOTYLE L. Marsh Pennyworts, Water Pennyworts, Navelworts

Mostly glabrous, creeping or floating perennials. Roots fibrous, from the nodes. Leaves simple, peltate, cordate, or reniform, one to a node; blades crenate, shallowly lobed, dentate, or entire. Inflorescences variable. Flowers regular, perfect, few to many. Calyx-teeth obsolete. Petals greenish or white, sometimes tinged with rose, spreading, not recurved at tips. Stamens and styles shorter than petals, maturing at about the same time. Stylopodium depressed. Ovary smooth, strongly laterally flattened. Fruit strongly laterally flattened, as broad or broader than tall; ribs primary. Carpophore absent. Oil-tubes absent; oil-cells usually present. Endocarp usually stony. Seed laterally flattened.

Leaves peltate.

Inflorescence of simple umbels, rarely weakly proliferous ..... 1. *H. umbellata*

Inflorescence of whorls of flowers or fruits at intervals along a single, bifurcating, or more extensively branched rachis.

Inflorescence with a single or bifurcating rachis.

Flowers and fruits sessile or subsessile ..... 2. *H. verticillata*

Flowers and fruits pedicellate ..... 2a. *H. verticillata* var. *triradiata*

Inflorescence branching into a dendritic pattern at maturity, these branches being simple, bifurcating, or whorled ..... 3. *H. bonariensis*

Leaves not peltate.

Leaf blades with a distinct terminal lobe, clefts extending approximately ½ distance from margin to petiole attachment ..... 4. *H. ranunculoides*

Leaf blades not deeply lobed; lateral lobes cut about same depth as terminal one.

Peduncles absent or short, rarely up to 2 cm., much shorter than petioles of same node; only one leaf from a node; flowers and fruits on short pedicels; mature leaves usually over 13 mm. broad ..... 5. *H. americana*

Peduncles always distinct, at maturity about equaling or exceeding petioles of same node; some nodes with more than one leaf; flowers and fruits sessile or subsessile; mature leaves less than 13 mm. broad.....6. *H. sibthorpioides*

1. *Hydrocotyle umbellata* L. Marsh Pennywort, Water Navelwort, Umbellate Marsh Pennywort.

Leaves shallowly lobed, dentate, or crenate; umbels subequal or exceeding the leaves; flowers 30–50 to an umbel; fruit (Fig. 1) 2–3 mm. wide and 1–2 mm. high, shallowly cordate at base; lateral and dorsal ribs very corky, intermediates much narrower; mericarps widest at commissure and narrow at outer edge.—Native. Flowers from spring to fall.

DISTRIBUTION: Low places, pools, ditches, and stream banks; chiefly on coastal plain. Fla. to Tex., north to N. S. and Minn.; Calif. and Ore.; C. A., S. A., and old World; in Southeast (Map I), known or reported from every state.

SPECIMENS CITED: ALABAMA: Autauga, Smith, Aug. 18, 1897 (US); Baldwin, Schallert 514 (DUKE); Mobile, Mackenzie 4045 (NY). FLORIDA: Alachua, Miller, 415 (US); Brevard, Fredholm 5918 (GH); Bradford, West & Arnold, May 15, 1940 (FLA); Broward, Small & Carter 1161 (NY, PH); Citrus, West & Arnold, May 15, 1940 (FLA); Clay, Moldenke 5238 (NY); Columbia, Rolfs 146 (FLA); Dade, Small & Carter 2636 (NY); De Soto, Small 8190 (FLA, NY); Duval, Moldenke 173a (DUKE); Escambia, Collins, May 12, 1917 (GH); Flagler, West & Arnold, April 18, 1940 (FLA); Franklin, McAtee 1717 (US); Gilchrist, Hixon, Arnold, & West, Aug. 15, 1944 (FLA); Hamilton, West & Arnold, Sept. 30, 1941 (FLA); Hernando, Jones 62 (US); Highlands, McFarlin 10143 (FLA); Hillsborough, Barnard 2222 (NY); Jefferson, Spurry 523 (US); Lafayette, West & Arnold, May 20, 1940 (FLA); Lake, Nash 351 (GH, PH, US); Lee, Hitchcock 128 (US), 129 (GH); Leon, Moldenke 1115 (DUKE, NY); Marion, West & Arnold, May 27, 1940 (FLA); Orange, Walker 1762 (PH); Osceola, Singeltary 186 (DUKE, NCS); Palm Beach, Randolph 186 (GH); Pasco, O'Neill 8182 (US); Polk, Milligan, March, 1888 (US); Putnam, Laessle, April 21, 1940 (FLA); Sarasota, Smith, March 2, 1904 (DUKE); St. Lucie, Small et al. 9288 (NY); Volusia, Straub 142 (GH). GEORGIA: Charlton, Harper 1471 (GH, NY, US); Chatham, Eyles 1817 (DUKE); Glynn, Leeds 2823 (PH); Richmond, Cuthbert, May, 1881 (FLA); Screven, Eyles 7566 (GA). LOUISIANA: Avoyelles, McAtee 2220 (US); East Baton Rouge, collector unknown, June, 1858 (NY); Feliciana (East or West?), Carpenter, 1840 (US); Lafayette, Claycomb, July 8, 1942 (GH); Rapides, Hale, no number or date (NY, PH); Saint Tammany, collector unknown, Nov. 16, 1894 (US). MISSISSIPPI: Harrison, Baker 788 (PH), 779 (NY); Jackson, Seymour 919941 (DUKE, GH, NCU). NORTH CAROLINA: Beaufort, Rodgers 354C (NCU); Bladen, Blomquist 4400 (DUKE); Brunswick, Rodgers 289C (NCU); Carteret, Rodgers 857C (NCU); Chowan, Rodgers 558C (NCS, NCU); Columbus, Wiegand & Manning 2275 (GH); Craven, Correll 1466 (DUKE); Currituck, Rodgers 533C (NCU);

Dare, Rodgers 527C (NCU); Greene, Correll 1343 (DUKE); Harnett, Oosting 1914 (DUKE); Hoke, Rodgers 573C (NCU); Hyde, Mathews, 1931 (NCU); Martin, Rodgers 501C (NCU); Moore, Oosting 33742 (DUKE); New Hanover, Rodgers 304C (NCU); Onslow, Rodgers 865C (NCU); Pamlico, Rodgers 352C (NCU); Pasquotank, Oosting 35501 (DUKE); Pender, Rodgers 866C (NCU); Perquimans, Rodgers 548C (NCU); Pitt, Rodgers 493C (NCU), Sampson, Godfrey, June 11, 1938 (DUKE); Scotland, Godfrey 5085 (DUKE, GH); Tyrrell, Rodgers 512C (NCU); Wake, Ashe, Aug., 1897 (NCU); Wayne, Rodgers 202AC (GH, NCU). SOUTH CAROLINA: Aiken, Radford 542 (NCU); Beaufort, Cuthbert, May, 1899 (FLA); Berkeley, Hunt 8806 (CLEMS); Charleston, Godfrey & Tryon 1101 (GH, NY); Clarendon, Stone 689 (PH); Darlington, Smith 1600 (NCU); Georgetown, Raynal, Sept. 20, 1937 (NCU); Horry, Coker, July 31, 1945 (NCU); Lexington, McGregor 180 (US). TENNESSEE: Reported from Davidson County by Gattinger.

2. *Hydrocotyle verticillata* Thunb. Whorled Marsh Pennywort.

Leaves crenate to almost entire; inflorescence with 3–7 nodes; flowers and fruits 2–7 to a node; fruit 2–4 mm. wide and 1–3 mm. high, cuneate or almost truncate at base; lateral and dorsal ribs very corky, intermediates narrow; mericarps widest at commissure and acute on outer edge.—Native. Flowers from spring to fall.

DISTRIBUTION: Wet places, particularly in mud; coastal plain. Tex. and Mo., east to Fla. and up the coast to Mass.; from Tex. westward to Utah, Calif., and Ore.; in Southeast (Map II), all states except Tenn.

SPECIMENS CITED: ALABAMA: Autauga, Svenson & Harper 9489 (GH); Escambia (?), Eggert, July 9, 1898 (NY); Houston, Wiegand & Manning 2280 (GH); Lee, Earle & Baker, July 8, 1897 (NY); Mobile, Mohr, no number or date (US). FLORIDA: Alachua, Arnold, April 7, 1932 (FLA); Brevard, Fredholm 6210 (GH, NY); Broward, Bush 86 (NY); Citrus, Murrill, June 6, 1941 (FLA); Clay, Canby, March, 1868 (US), March, 1869 (GH, NY, PH); Columbia, Nash 2485 (FLA, GH, NCU, PH, US); Dade, Elder 440 (DUKE); De Soto, Small 8175 (NY); Duval, Curtiss 4963 (GH, US); Jackson, Bush 88 (NY); Lee, Hitchcock 126 (GH, US); Manatee, Tracy 6837 (GH, NY, US); Monroe, Small & DeWinkeler, April 28, 1921 (DUKE, FLA); Orange, Fredholm 5364 (GH); Palm Beach, Curtiss 5377 (GH); Pinellas, Williams, Feb. 16, 1926 (PH); Putnam, Curtiss 992 (US); Sarasota, Moldenke 5918 (NY); St Johns, Reynolds, 1877 (NY); Union, West & Arnold, May 22, 1942 (FLA); Volusia, Arnold, May 1, 1934 (FLA). GEORGIA: Baldwin, Short, no number or date (PH); Bibb, collector and date unknown (PH); Camden, Wiegand & Manning 2279 (GH); Clay, Harper 1789 (NY, US); Glascock, Harper 1323 (GH, NY, US); Houston, Ainsworth 446047 (PH); Jasper, collector and date unknown (PH); Miller, Thorne 6382 (US); Richmond, Cuthbert, 1903 (FLA). LOUISIANA: Bossier, Correll 10254 (DUKE); Calcasieu, MacKensie 520 (NCU, NY); Livingston, Correll 1971 (DUKE); Orleans, Purly (?), Feb. 10, 1910 (NY); Rapides, Hale, no number or date (PH); Saint

Tammany, Arsene 11417 (US). MISSISSIPPI: Harrison, Tracy 4471 (US). NORTH CAROLINA: Bladen, Biltmore Herbarium 2542a (GH, NY, US); Brunswick, Rodgers 314C (NCU); Camden, Rodgers 540C (NCU); Carteret, collector and date unknown (NY); Columbus, Rodgers 880C (NCU); Craven, Rodgers 341AC (NCU); Currituck, Rodgers 535C (NCU); Duplin, Rodgers 876C (NCU); Edgecombe, Rodgers 568C (NCU); Greene, Rodgers 846C (NCU); Lenoir, Rodgers 847C (NCU); New Hanover, collector and date unknown (NY); Pasquotank, Rodgers 543C (NCU); Perquimans, Rodgers 551C (NCU); Sampson, Rodgers 878C (NCU); Tyrrell, Rodgers 517C (NCU). SOUTH CAROLINA: Aiken, Ravenel, no number or date (US); Beaufort, Mellichamp 1179 (US); Berkeley, Godfrey & Tryon 627 (GH, NY), 628 (US); Charleston, Hexamer & Maier, May 17, 1855 (GH); Darlington, Smith 1470 (NCU); Williamsburg, Godfrey & Tryon 533 (DUKE, GH, NY, PH, US). TENNESSEE: None.

2a. *Hydrocotyle verticillata* var. *triradiata* (A. Rich) Fern. (*H. canbyi* C. & R.; *H. australis* C. & R.) Canby's Marsh Pennywort or Water-cup.

Inflorescences with 3–4 nodes; pedicels 1–10 mm. long, 4–15 to a node; fruit about 4 mm. wide and 2–2.5 mm. high, shallowly cordate at base and apex; lateral and dorsal ribs acute, very corky, intermediates much narrower; mericarps widest at commissure and narrow at outer edge.—Native. Flowers from spring to fall.

DISTRIBUTION: Wet places, mud or sand; coastal plain. Fla. north to Mass., Fla. west to Texas, Nev., and Calif.; south to S. A.; in Southeast (Map II), all coastal states except Ala. (probably present there, also).

SPECIMENS CITED: ALABAMA: None. FLORIDA: Alachua, West, April 26, 1935 (FLA); Dade, Small 8066 (NCU); Duval, Curtiss 922 (FLA, PH, US); Escambia, Macfarlane & Goertz, June 17, 1905 (DUKE); Hillsborough, Williamson, Aug., 1894 (PH); Palm Beach, Curtiss 5376 (FLA, GH, NY); St. Johns, Reynolds, 1877 (PH). GEORGIA: Thomas, Small, May 28–June 6, 1895 (NY). LOUISIANA: Jefferson, Ball 354 (GH, NY); Orleans, Moore, no number or date (NY). MISSISSIPPI: Label illegible, March, 1874 (GH). NORTH CAROLINA: Beaufort, Rodgers 354C (NCU); Brunswick, Rodgers 281C (NCU); Camden, Rodgers 536C (NCU); Carteret, Godfrey, Fox, & Blomquist 49571 (NCS); Chowan, Rodgers 554C (NCU); Craven, Rodgers 339AC (NCU); Currituck, Godfrey & Fox, June 10, 1949 (NCS); Dare, Rodgers 524C (NCU); Edgecombe, Rodgers 490C (NCU); Hyde, Ashe, June 16, 1898 (NCU); Jones, Rodgers 344C (GA, NCU); Martin, Rodgers 500C (NCU); Onslow, Rodgers 874C (NCU); Pamlico, Rodgers 346AC (NCU); Perquimans, Rodgers 553C (NCU); Pitt, Rodgers 492C (NCU); Washington, Rodgers 508C (NCU). SOUTH CAROLINA: Beaufort, Cuthbert, no number or date (FLA); Charleston, Hunt 228 (CLEMS); Horry, Coker, July 31, 1945 (NCU); Sumter, Stone, May 25, 1914 (PH). TENNESSEE: None.

3. *Hydrocotyle bonariensis* Lam.

Leaves shallowly dentate or crenate-dentate, surface appearing roughish when old; umbels exceeding leaves in length; fruit about 3 mm. wide and 2 mm. high, cordate at base; lateral and dorsal ribs very corky, intermediates much narrower; medicarps widest at commissure and narrow at outer edge.

DISTRIBUTION: Sandy places, wet or dry, near the coast. Fla. to N. C. and Tex.; south to S. A.; in Southeast (Map I), every coastal state.

SPECIMENS CITED: ALABAMA: Mobile, Howell 750 (US). FLORIDA: Bay, Martin 1661 (DUKE); De Soto, Schallert, July 29, 1950 (GH); Duval, Small 9695 (NY); Escambia, Curtiss 5922 (FLA, GH, NCU, NY, US); Franklin, Moldenke 1149 (NY); Gulf, Moldenke 1147 (DUKE); Lee, Eaton 1417 (GH); Manatee, Correll 5878 (DUKE, GH); Nassau, West & Small, Aug. 9, 1935 (FLA); Okaloosa, Hickernell, March 15, 1949 (FLA); St. Johns, Browne A-32 (NCU); Santa Rosa, Fassett 19865 (NY); Volusia, Rau (?), March, 1919 (PH); Walton, Curtiss, summer, 1885 (NY). GEORGIA: Glynn, Cronquist 5360 (FLA, GH, US). LOUISIANA: Jefferson, Andrews 2 (NY); Plaquemines, Langlois 50 (US). MISSISSIPPI: Hancock, Browne A-51 (NCU); Harrison, Pollard 1153 (GH, NY, US); Jackson, Tracy 6390 (GH, NY, US). NORTH CAROLINA: Brunswick, Rodgers 323C (NCU); Carteret, Ulmer, July 9, 1947 (DUKE); Hyde, Mathews, summer, 1931 (NCU); New Hanover, Biltmore Herb. 5708 (US); Pamlico, Rodgers 351C (NCU). SOUTH CAROLINA: Charleston, Schallert 1651 (DUKE); Horry, Coker & Totten, July 12, 1932 (NCU). TENNESSEE: None.

4. *Hydrocotyle ranunculoides* L. f. Floating Marsh Pennywort.

Plants floating or creeping; leaves with distinct lobes; inflorescences opposite leaves and much shorter (2.5–6.5 cm. long), tending to recurve, 5–10 pedicellate flowers or fruits to umbel; petals greenish; fruit with cordate base, broader than apex, not corky; oil-cells scattered, not in a layer.—Native. Flowers from spring to fall.

DISTRIBUTION: Pools, ditches, swamps, and wet banks; coastal plain and up Miss. River Valley. Tex. and Ariz., up east coast to Penn. and west coast to Wash.; S. A. and Old World; in Southeast (Map I), all states (reported in Tenn.).

SPECIMENS CITED: ALABAMA: Mobile, Baker, March 18, 1897 (PH). FLORIDA: Franklin, Curtiss 5886 (FLA, GH, NCU, US). GEORGIA: CHATHAM, Smith 407 (US). LOUISIANA: Orleans,—(illegible), 1935 (NY); Rapides, Hale, no number or date (PH). MISSISSIPPI: Leflore, Barber, May 27, 1925 (DUKE). NORTH CAROLINA: Chowan, Kearney 1908 (US); Currituck, reported by McAtee on Church's Island; Dare, Rodgers 528C (DUKE, GA, NCS, NCU, NY); New Hanover, Godfrey & Wells 4309 (GH, NCS, US). SOUTH CAROLINA: BERKELEY, Hunt & Martin 1525 (CLEMS). TENNESSEE: Coffee, reported by Gattinger.

5. *Hydrocotyle americana* L. American Pennywort, Penny-post, Marsh Pennywort.

Slender creepers; tuberous; leaves thin, shallowly lobed, lobes with 3–8 crenations; petals greenish; fruit about 1.75 mm. broad and 1.25 mm. tall, cordate at base; ribs filiform.—Native. Flowers from spring to fall.

DISTRIBUTION: Swamps, stream banks, and low woods; mts. of this state. N. C. to Newf., west to Wis.; in Southeast (Map I), N. C. and Tenn., reported from S. C.; specimen labeled Polk Co., Fla., is probably an error.

SPECIMENS CITED: NORTH CAROLINA: Buncombe, Biltmore Herb. 4003a (GH, NY, US); Macon, Rodgers 604C (DUKE, GA, NCS, NCU, US); Transylvania, Rodgers 635C (GA, NCS, NCU), 634C (NCU). (SOUTH CAROLINA: Reported by Ives and Coulter.) TENNESSEE: Polk, reported by Gattinger; Van Buren, J. K. U. & Sharp, July 19, 1935 (PH). FLORIDA: Polk, McFarlin, 1925 (FLA), probably an error in location.

6. *Hydrocotyle sibthorpioides* Lam. (*H. rotundifolia* Roxb.) Asiatic Pennywort, Lawn Pennywort.

Small, delicate creepers; leaves thin, lobed, each lobe with 3 crenations; fruit about 1–1.5 mm. broad and tall, ribs filiform.—Introduced weed. Flowers from spring to fall.

Mrs. W. B. Ward sent a specimen from her lawn at Concord to North Carolina State College. Since then collections have been made from along the paths in Duke University Garden and from the Duke Hospital lawn. It will probably be seen more often in the future. Hansen (1921) reports that it becomes a nuisance on lawns and golf courses.

DISTRIBUTION: Lawns, flower gardens, golf courses, and greenhouses. Known from La., Ga., N. C., D. C., Penn., Ky., and Ind.; in Southeast (Map I).

SPECIMENS CITED: GEORGIA: Richmond, (greenhouse), Cuthbert, no number or date (FLA). LOUISIANA: Orleans, Pennell 10183 (NY). NORTH CAROLINA: Cabarrus, Ward, Oct. 14, 1946 (NCS); Durham, Rodgers 893C & 900 (NCU).

2. CENTELLA L.

Glabrous to densely arachnoid perennials. Roots from nodes, fibrous. Leaves simple, palmately-veined, petiolate. Flowers regular, perfect. Calyx-teeth absent. Petals white or greenish, often tinged with rose, spreading, not recurved at tips. Stamens and styles shorter than petals. Stylopodium depressed. Ovary and fruit strongly laterally flattened; fruit (Fig. 2) with primary ribs, secondary ribs, and reticulations. Carpophore not distinct. Endocarp stony. Oil-tubes mostly absent. Seed laterally flattened.

1. *Centella erecta* (L. f.) Fern. (*C. asiatica* [L.] Urban; *C. repanda* [Pers.] Small) Ovate-leaved Pennywort, Ovate-leaved Marsh Pennywort, Intelligence Plant, Ovate Water-cup.

Plants slender, creeping; 1–7 leaves from each node; leaves ovate to oblong, apexes rounded, bases cordate or truncate, margins entire, sinuate, or dentate; inflorescences 1–5 from a node, usually much shorter than petioles from the same node; flowers 1–4, usually 3 in each inflorescence, pedicellate to nearly sessile; petals triangular and widely spaced, usually some pubescence on the under surface; anthers purple; fruit broader than tall; oil-layer below epidermis. —Native. Flowers from spring to fall.

DISTRIBUTION: Low moist places; coastal plain. Coastal states from Tex. to Del. and Md.; on ballast in Ore.; Mex., S. A., and Old World; in Southeast (Map II), every state except Tenn.

SPECIMENS CITED: ALABAMA: Lee, Tracy 6682 (NY); Mobile, Mohr, July, 1879 (US). FLORIDA: Alachua, Kelbert & West 86 (FLA); Baker, West & Arnold, April 25, 1940 (FLA); Bradford, West & Arnold, May 15, 1940 (FLA); Broward, Moldenke 592 (DUKE, NY); Citrus, West & Arnold, June 24, 1941 (FLA); Clay, Martin, April 15, 1885 (PH); Dade, Small 8053 (NCU); Dixie, Pasture Survey, Aug. 11, 1937 (FLA); Duval, Curtiss 988 (FLA, GH, PH); Escambia, Macfarlane, June 17, 1905 (DUKE); Flagler, West & Arnold, April 18, 1940 (FLA); Franklin, Biltmore Herbarium 4004C (GH, NY, US); Gilchrist, DeVall & Arnold, May 18, 1940 (FLA); Glades, Lovett 267 (DUKE); Hamilton, West & Arnold, Sept. 30, 1941 (FLA); Hardee, Kirk, July 8, 1942 (FLA); Hillsborough, Garber, May, 1878 (US); Jefferson, Exploration Party, March 16, 1939 (FLA); Lake, Nash 1031 (GH, PH, US); Lee, Standley 118 (HG, PH, US); Leon, Crevasse, Aug. 16, 1940 (FLA); Levy, Pasture Survey, Aug. 20, 1937 (FLA); Marion, West & Arnold, May 15, 1940 (FLA); Nassau, West & Arnold, June 3, 1942 (FLA); Osceola, Singeltary 229 (DUKE, NCS); Palm Beach, Randolph 41 (GH); Polk, Smith, March, 1879 (US); Putnam, Curtiss 922 (US); Saint Johns, Curtiss 6228 (FLA, NCU); Sumter, Scott, Dec. 22, 1933 (DUKE); Union, West & Arnold, May 22, 1942 (FLA); Volusia, Hood, March, 1912 (FLA). GEORGIA: Berrien, Lemon, Oct. 30, 1940 (FLA); Camden, Biltmore Herbarium 4004e (PH); Charlton, Harper 193 (PH); Chatham, Crawford, July 25, 1923 (PH); Colquitt, Harper 1942 (GH, NY, US); Glynn, Lee, March 28, 1914 (NY); McIntosh, Small, June 25–27, 1895 (NY); Sumter, Harper, July 27, 1897 (NY); Ware, Meyell 255 (PH); Worth, Svenson 6953 (GH). LOUISIANA: Calcasieu, Mackensie 521 (NCU); Orleans, collector and date unknown (GH). MISSISSIPPI: Harrison, Tracy, Earle, & Seymour 919521 (DUKE, NCU); Jackson, Seymour 919237a (DUKE). NORTH CAROLINA: Brunswick, Rodgers 320C (NCU); Carteret, Rodgers 854C (NCS, NCU); Columbus, Rodgers 336C (NCU); Craven, Rodgers 852C (NCU); Currituck, Rodgers 534C (NCU); Dare, Rodgers 523C (NCU); Hyde, Rodgers 519C (NCU); New Hanover, Rodgers 303C (NCU); Onslow, Rodgers 862C (NCU); Pamlico,

Rodgers 344AC (DUKE, NCU); Robeson, Rodgers 879C (NCU); Tyrrell, Rodgers 509C (NCU); Washington, Rodgers 506C (NCU). SOUTH CAROLINA: Beaufort, Godfrey & Tryon 11531 (GH, NY); Berkeley, Wiegand & Manning 2247 (GH, NY); Charleston, Gibbes, summer, 1859 (NY); Darlington, Coker, 1908 (NCU, NY); Georgetown, Godfrey & Tryon 769 (DUKE, GH, NY, PH, US); Horry, Coker, July 27, 1946 (NCU); Orangeburg, Eggleston 5005 (GH, NY, US). TENNESSEE: None.

3. *Eryngium* L. Button Snakeroots, Eryngos.

Glabrous, erect or creeping biennials or perennials. Roots fibrous. Leaves usually tough and simple, often spiny. Heads commonly cymose. Bracts subtending each flower or fruit, variously shaped, sometimes spiny; lower whorl usually much larger. Flowers perfect, regular, sessile. Calyx-segments well developed, persistent. Petals white, greenish, blue, or purple, erect, recurved at tips. Stamens and styles longer than petals. Stylopodium absent; disk present. Ovary and fruit (Fig. 3) covered with hollow, hyaline scales or tubercles. Carpophore absent. Oil-tubes in primary areas. Seed subterete.

Plants erect.
Veins of leaves parallel; all bracts simple, aristate to acute; flowers greenish or white
1. *E. yuccifolium*
Veins of leaves netted; bracts with spines, the upper tricuspidate; flowers bluish.
Blades of leaves rarely over 5 or 6 cm. long or 3 cm. wide, seldom over three times as long as wide ..... 2. *E. integrifolium*
Blades of leaves elongate, obviously over three times as long as wide
3. *E. aquaticum*

Plants creeping or weakly ascending.
Bracts at base of heads equal or longer than heads; leaves tapering or palmately lobed at base, sometimes so deeply lobed that they almost appear compound
4. *E. prostratum*
Bracts at base of heads shorter than heads; leaves pinnatifid or pinnate
5. *E. divaricatum*

1. *Eryngium yuccifolium* Michx. (*E. aquaticum* L. [in part]) Eryngo, Button Snakeroot, Rattlesnake Master, Water Eryngo, Corn Snakeroot, Rattlesnake Flag, Rattlesnake Weed.

Perennials with yucca-like leaves; base corm-like; leaves with bristles on margin, bristles usually solitary; basal leaves in a rosette; cauline leaves much smaller; heads globose-ovoid; bracts mostly 1-nerved, longer than ovaries and fruits; flowers white or greenish; fruits and seeds slightly dorsally flattened (Fig. 3) or terete.—Native, sometimes planted in yards. Flowers from spring to fall.

A variety with leaves armed with more than one bristle to a place ranges farther south. Some plants from the coastal plain may appear somewhat intermediate between the species and variety. Two examples of these are Rodgers' collection 870C (NCU) from Pender Co., N. C., and Coker's collection of July 13, 1932 (NCU), from Horry Co., S. C.

DISTRIBUTION: Open places—savannas, bogs, pastures, dry banks, and occasionally in deep woods; mts., pied., and coastal plain. Fla. to Tex., north to Conn. and Minn.; in Southeast (Map VII), all states.

SPECIMENS CITED: ALABAMA: Lee, Pollard & Maxon 78 (NY, US); Mobile, Mohr, July, 1870 (US). FLORIDA: Brevard, Rhoads, June 10, 1937 (DUKE, FLA); Broward, Brown & West, April 16, 1928 (NY, US); Collier, Scull, June 21, 1937 (FLA); Dade, Small & Nash 80 (NY); Escambia, Tisdale, Aug. 12, 1932 (FLA); Gadsden, Chapman, no number or date (NY); Hillsborough, Garber, May, 1874 (PH); Jackson, Biltmore Herbarium 414c (NY); Levy, Garber, June, 1876 (PH); Palm Beach, Fox, June 5, 1945 (NCS); Wakulla, Small et al. 9576 (NY, US). GEORGIA: Baker, Thorne 5402 (US); Habersham, collector unknown, Sept. 1–3, 1894 (NY); Jasper, collector and date unknown (PH); Jenkins, Duncan 9888 (GA, NCU); Meriwether, Harper 1270 (GH, NY, US); Rabun, Cuthbert, Aug. 5, 1889 (FLA); Richmond, McCarthy, Sept., 1888 (NCS); Stephens, Duncan 10021 (GA); Walker, Ruth 421 (NY), 424 (US); Upson, Cronquist 5505 (US). LOUISIANA: Acadia, Degener 5125 (NY); Calcasieu, Correll 9644 (DUKE); Rapides, Ball 632 (US); St. Tammany, Arsene 11667 (US); Tangipahoa, Correll 9311 (DUKE, GH). MISSISSIPPI: Harrison, Tracy 6467 (NCU); Jackson, Pollard 1043 (US); Leake, McDougall 1394 (US). NORTH CAROLINA: Alamance, Ashe, Oct., 1895 (NCU); Brunswick, Rodgers 890C (NCU); Buncombe, Biltmore Herb. 414b (NY); Burke, Rodgers 727C (GA, NCU); Caldwell, Randolph 1121 (GH); Catawba, Small & Heller, June 25–26, 1891 (PH, US); Clay, Rodgers 616C (NCU); Columbus, Rodgers 887C (NCU); Durham, Blomquist 7421 (DUKE); Forsyth, Schallert, Sept. 1, 1932 (NY); Granville, Rodgers 405C (NCU); Harnett, Radford & Stewart 649 (NCU); Haywood, Haliburton 74 (DUKE); Henderson, Rodgers 644C (NCU); Hyde, Correll 1749 (DUKE); Jackson, Thaxter, June–July, 1887 (GH, US); Macon, Rodgers 607C (NCU); Montgomery, Oosting 1880 (DUKE); New Hanover, reported by Curtis & Wood & McCarthy; Orange, Rodgers 392AC (NCU); Pender, Rodgers 870C (GA, NCU, NY); Person, Rodgers 398C (NCU); Polk, Peattie 1091 (NCU); Rowan, Heller 60 (NY, PH); Surry, Rodgers 787C (NCU); Swain, Hunnewell 10451 (GH); Wake, Rodgers 470C (NCU); Warren, Rodgers 414C (NCU). SOUTH CAROLINA: Berkeley, Godfrey & Tryon 855 (DUKE, GH, NY, US); Charleston, Hunt (CLEMS); Darlington, Smith 1473 (NCU); Florence, Talbert & Armstrong, no number or date (CLEMS); Georgetown, Godfrey & Tryon, July 26, 1939 (GH, NY, US); Greenville, Thomason, Aug. 13, 1935 (FUR); Horry, Coker, July 13, 1932 (NCU); Oconee, House 2898 (NY, US); Pickens, Rodgers 233 (DUKE); Sumter, Stone 362 (PH). TENNESSEE: Bledsoe, E. B. H. 7708 (TENN); Bradley, Wherry & Pennell 13994 (PH); Chester, Bain 113 (NY); Coffee, Ford & Russell 2308 (TENN); Cumberland, Coffman 247 (US); Hamilton, Lippincott, Oct. 19, 1895 (PH); Hickman, Sharp & Clebsch 446 (TENN); Knox, Ruth 2842 (NCU); Lewis, Shanks, Clebsch, & Sharp 5763 (TENN); Rhea, Shanks, Sharp, & Clebsch 4369 (TENN); Roane, collector unknown, 1920 (TENN); Van Buren, Shanks, Sharp, & Clebsch 4525 (TENN); White, Sharp, Shanks, & Clebsch 5452 (TENN).

2. *Eryngium integrifolium* Walt. (*E. virgatum* Lam.) Virgate Button Snakeroot, Sea Holly.

Plants slender, up to 9 dm. tall; basal leaves with petioles longer than the elliptic or oblong blades; lower cauline leaves similar, but with short petioles; upper cauline leaves with elliptic, lanceolate, ovate, or oblong blades, longer than petioles; leaf margins entire to coarsely stiff-toothed, sometimes cut; heads globose or ovoid; bracts subtending head linear, equaling or up to twice as long as head, commonly with 2 (often 4–5) spines near base; flowers blue.—Native. Flowers in summer and fall.

DISTRIBUTION: Grass bogs, cane brakes, and savannas; most abundant on coastal plain. Fla. to Tex., north to N. C. and Okla.; in Southeast (Map VII), every state.

SPECIMENS CITED: ALABAMA: Butler, Smith, Aug. 21, 1884 (GH, US); Choctaw, Watson, 1857 (GH); Escambia, Blanton 129 (GH); Lee, Earle & Baker, Sept. 25, 1897 (PH); Mobile, Harvey 18 (US); Tuscaloosa, Vasey 480 (US). FLORIDA: Alachua, Murrill 108 (US); Baker, Curtiss 6008 (FLA, GH, NCU, NY, US); Bay, Billington 9 (US); Calhoun, Hood 2746 (FLA); Clay, O'Neill, Sept. 30, 1929 (US); Escambia, Tisdale, Sept. 14, 1946 (FLA); Franklin, Biltmore Herb. 2357a (GH, NY); Gadsden, Nash 2573 (FLA, GH, NCU, NY, PH, US); Holmes, Curtiss, Aug. 26, 1884 (GH); Jackson, Knight, Oct. 21, 1941 (FLA); Liberty, Curtiss, Aug. 27, —— (NY); Okaloosa, Hood 3123 (FLA); Wakulla, Nash 2539 (GH, NY, PH, US); Walton, Curtiss 1000 (NY, PH, US); Washington, Senner, Aug. 31, 1942 (FLA). GEORGIA: Baldwin, Boykin, no number or date (PH); Bartow, Duncan 8687 (FLA); Clayton, Duncan 9559 (GA); Coffee, Harper 709 (NY); Colquitt, Harper 1665 (GH), 1664 (NY); Columbia, Chapman, 1832 (NY); Coweta, Wiegand & Manning 2262 (GH); Jasper, Porter, no number or date (GH); Jefferson, Hopkins, Oct. 18, 1901 (NY); Jenkins, Cleveland, no number or date (FLA); Liberty, LeConte, no number or date (NY); Long, Duncan 7130 (GA, NCU); Lowndes, Harper 1612 (GH, NY, US); Meriwether, Harper 1252 (GH, NY, US); Polk, collector unknown, Sept., 1891 (US); Sumter, Harper 422 (GH); Thomas, Harper 1181 (NY, US); Union, Wherry & Pennell 14049 (PH); Worth, Pollard & Maxon 547 (NY). LOUISIANA: Calcasieu, Mackenzie 518 (NY); Feliciana (East of West ?), Carpenter (PH); Natchitoches, Palmer 8808 (PH); Orleans, collector and date unknown (GH); Rapides, Hale, no number or date (NY, PH); St. Tammany, Pennell 4177 (NY); Webster, Correll 10312 (DUKE, GH, NCS, NY, PH). MISSISSIPPI: Forest, Oosting 1968 (DUKE); Harrison, Tracy 4479 (GH); Jackson, Seymour & Earle 91822103 (DUKE, GH, NCU); Pearl River, Kearney, Oct. 12, 1896 (NY); Simpson, Tracy 8437 (GH, NY, US). NORTH CAROLINA: Bladen, Blomquist, Aug. 17, 1932 (DUKE); Brunswick, Rodgers 889C (GA, NCU); Buncombe, Biltmore Herb. 2357b (GH, NCU, NY, US); Burke, Blomquist, July 30, 1933 (DUKE); Carteret, Rodgers 853C (GA, NCS, NCU, NY); Cherokee, Ashe, Sept., 1893 (NCU); Columbus, Rodgers 881C (GA, NCS, NCU, NY); Craven, Rodgers 853AC (DUKE) (NCU); Haywood, reported by Harper; Henderson, Rodgers 643C (GA, NCS,

NCU, NY, US); Iredell, Hyams, July, 1878 (NY, US); Johnston, Blomquist 10538 (DUKE); Nash, Godfrey & Kerr, Oct. 8, 1938 (DUKE, NCS); New Hanover, Radford 659 (NCU); Onslow, Rodgers 873C (DUKE, NCS, NCU); Pamlico, Godfrey & White, Oct. 13, 1938 (DUKE, GH, NCS); Pender, Rodgers 869C (NCU); Richmond, Williamson, Aug. 1, 1896 (PH); Swain, Beardslee & Kofoid, Aug. 28, 1891 (GH, NY, US); Wake, Hyams, no number or date (NCU). SOUTH CAROLINA: Anderson, Davis 7827 (US); Berkeley, Coker, Aug. 29, 1902 (NCU); Charleston (?), Porcher, no number or date (NY); Darlington, Norton, June, 1921 (NCU); Dorchester, Hunt 1183a (CLEMS); Georgetown, Totten, Sept. 7, 1940 (NCU); Horry, Schallert, Sept. 1, 1940 (GH). TENNESSEE: McNairy, Svenson, Aug. 28, 1930 (GH, PH).

3. *Eryngium aquaticum* L. (E. *virginianum* Lam.) Marsh Button Snakeroot, Virginian Eringo.

Plants perennial, up to 12 dm. tall; leaves linear to lanceolate or oblanceolate, margins entire, crenate, or serrate, apex acute or obtuse; basal leaves with petioles longer than blades; cauline leaves with blades longer than petioles; upper leaves sessile; heads subglobose; bracts of lower series about equal to or up to twice length of heads, 1-nerved, usually with 2–3 spines; other bracts tricuspidate, the center spine longest; flowers blue.—Native. Flowers in summer and fall.

A variety having bracts with three equal spines ranges farther south.

DISTRIBUTION: Swamps and margins of streams; coastal plain. Ala. and Ga. to N. J.; in Southeast (Map VII), Ala., Ga., S. C., and N. C. (Small gives the range as far west as Tex.).

SPECIMENS CITED: ALABAMA: Mobile, Mohr, Sept. 10, 1882 (US). FLORIDA: None. GEORGIA: Chatham, Hopkins 30 (NY); Effingham, Harper 1839 (GA, NY, US); Liberty, LeConte, no number or date (NY); McIntosh, Small, June 26, 1895 (NY). LOUISIANA: None. MISSISSIPPI: Reported by Lowe. NORTH CAROLINA: Beaufort, Radford & Stewart 773 (NCU); Brunswick, Godfrey & Wells 4888 (GH, NCS); Carteret, Rodgers 856C (GA, NCS, NCU); Chowan, Bartley & Pontius 504 (NY); Craven, Rodgers 851C (DUKE, GA, NCS, NCU, NY, US); Currituck, Barber, Aug. 28, 1948 (NCS); Hyde, Godfrey & White 6855 (DUKE, GH, NCS); New Hanover, Williamson, Aug., 1900 (PH); Onslow, Godfrey 6399 (GH, NCU, US); Pasquotank, Kearney 2009 (US); Tyrrell, Radford 5078 (NCU). SOUTH CAROLINA: Aiken, Ravenel, 1870 (NY); Beaufort, Mellichamp, 1875 (GH), 1887 (NY, US); Berkeley, Ravenel, no number or date (GH, NY); Charleston, Godfrey & Tryon 1143 (GH, NY, US); Georgetown, Godfrey 8131 (DUKE); Jasper, Wiegand & Manning 2258 (GH); Marion, Wiegand & Manning 2257 (GH). TENNESSEE: None.

4. *Eryngium prostratum* Nutt. Prostrate Eryngo.

Plants creeping perennials, sometimes rooting at the nodes; basal leaves ovate, lanceolate, or oblong, margins entire or toothed; cauline leaves clustered at

nodes, entire, with few teeth, or deeply 3-parted (appearing almost compound), short-petiolate or sessile; heads 4–9 mm. long, longer than wide; bracts subtending bottom flowers of head 5–10, equal or longer than heads; other bracts shorter than fruits; flowers blue.—Native.

In 1945, Fernald discovered *E. prostratum* in Southampton County, Virginia. He described it as a new variety (*E. prostratum* var. *disjunctum* Fern.), indicating that "its fruits are usually more elongate, tending to obconic, usually narrower than the typical form and with stipitate papillae." From the limited material available it is difficult to see a difference.

He noted the considerable distance between this new location and the Colleton County (South Carolina) station, which was the most northern location he knew. Actually, Fosberg had collected it at Motlow Creek in Spartanburg County, South Carolina, this station being further north and a little nearer Fernald's station. Fosberg's collection is particularly interesting, because it is from the very edge of the mountains while all other collections have been from the coastal plain.

No collections are known from North Carolina, but it may occur here.* It is often confused with *E. baldwini*, which is further south.

DISTRIBUTION: Low, wet places; chiefly coastal plain. Fla. to Tex., north to S. C., Va. (described as a variety), Ky., Mo., and Okla.; in Southeast (Map VII), all states except N. C.

SPECIMENS CITED: ALABAMA: Mobile, Mohr, 1897 (GH). FLORIDA: Alachua, Murrill, May 24, 1941 (FLA); Columbia, Rolfs, June 18, 1894 (FLA); Gadsden, Foster 30 (FLA); Gilchrist, Martin, DeVall, & Arnold, May 19, 1940 (FLA); Lafayette, West & Arnold, May 20, 1941 (FLA); Leon, Wiegand & Manning 2264 (GH); Levy, Murrill, April 24, 1941 (FLA); Suwanee, Wiegand & Manning 2265 (GH); Taylor, Wilmot & Murrill, May 13, 1941 (FLA). GEORGIA: Camden, Wood & Clement 7127 (GH); Decatur, Thorne 3953 (US); Jefferson, Pyron & McVaugh 1714 (US); Jenkens, Harper 777 (US); Sumter, Harper 1047 (GH, US); Thomas, Curtiss 6814 (GH, US); Ware, Williamson, no number or date (PH). LOUISIANA: East Baton Rouge, Ball 382 (US); Calcasieu, Allison, 1904 (GH, US); Feliciana (East or West ?), Carpenter, 1840 (US); Natchitoches, Palmer, May 3, 1915 (US); Rapides, Ball 472 (GH, US); St. Tammany, Arsene 12398 (US). MISSISSIPPI: Adams, Rhoades, July, 1931 (GH); Lauderdale, Tracy, June 6, 1891 (US); Scott, Anderson 4519 (DUKE); Simpson, Tracy 8631 (GH, US). NORTH CAROLINA: None. SOUTH CAROLINA: Colleton, Wiegand & Manning 2263 (GH); Spartanburg, Fosberg 18966 (NCU). TENNESSEE: Benton, Sharp, Clebsch, & Shanks 5945 (TENN); Carroll, Svenson 443 (GH); Chester, Bain, Aug., 1892 (US); Haywood, Gattinger, Aug., 1884 (GH); McNairy, Svenson 4334 (GH); Tipton, Sharp & Clebsch 6431 (TENN).

* Mr. R. K. Godfrey writes that he has collected a prostrate *Eryngium* on the Tar River, North Carolina. I have not yet seen his specimen but it may be this species.

5. *Eryngium divaricatum* H. & A.

Plants weak, slender-stemmed perennials; basal leaves pinnate or pinnately lobed, segments lanceolate, entire, and acute; cauline leaves similar, but segments closer together; flowers greenish.—Introduced.

This plant was collected on ballast by Gerald McCarthy at Wilmington in 1892. Additional collections either at Wilmington or elsewhere in the state are not known, and recent collecting in the same area failed to disclose it. It seems likely that it did not become permanently established. It was introduced at Pensacola, Florida, on ballast and collected by A. H. Curtiss in 1897.

DISTRIBUTION: Low waste-places. Introduced at Wilmington, N. C., and Pensacola, Fla. (Map VII).

SPECIMENS CITED: FLORIDA: Escambia, Curtiss, July 2, 1897 (NY). NORTH CAROLINA: New Hanover, McCarthy, June, 1892 (NY).

4. SANICULA L. Black Snakeroots, Sanicles.

Glabrous or pubescent, branching biennials or perennials. Roots fibrous, sometimes fleshy. Leaves palmately or pinnately compound or decompound, commonly palmately 3- or 5-foliate, basal blades often deeply cut. Umbels simple, cymosely displayed. Flowers in umbel usually 3 sessile or pedicellate perfect flowers and 0 to many staminate ones; some umbels entirely staminate. Flowers regular. Calyx-segments conspicuous, often sharp-pointed. Petals white, greenish, yellow, or purple, erect, recurved at tips. Stamens usually longer than petals. Styles shorter or longer than petals. Stylopodium absent; disk present. Ovary scaly and spiny. Fruit bristly, somewhat laterally flattened. Carpophore absent. Oil-tubes large and solitary in primary areas or numerous, small, and indefinitely arranged. Seed nearly terete; face plane to sulcate.

Styles shorter than calyx-segments of flower or fruit.
- Ovary or fruit on a short stalk; stamens long, exserted; mature fruit 5 mm. or less long, not distinctly beaked ..... 1. *S. canadensis*
- Ovary or fruit sessile or subsessile; stamens short, included; mature fruit 6 mm. long or longer, calyx-segments forming a distinct beak ..... 2. *S. trifoliata*

Styles longer than calyx-segments of flower or fruit.
- Styles less than twice the length of calyx-segments and not extending beyond tips of bristles in flowers and fruits; roots tuberous, not black; petals shorter than or almost equal calyx-segments; staminate flowers few, never in separate umbels, their sepals tending to spread apart and appear star-shaped when fruits mature, each of their inner surfaces with a conspicuous mid-nerve ..... 3. *S. smallii*

Styles much longer than calyx-segments and bristles in flowers and fruits; roots black, not tuberous; petals about equal or longer than calyx-segments; staminate flowers tending to be numerous, sometimes in separate umbels.
- Ovary or fruit sessile or subsessile; calyx-segments deeply cleft, awl-shaped; petals greenish-white, about equal or longer than calyx-segments; old staminate flowers on pedicels 3–4 mm. long, usually equal or exceeding length of mature fruit; plants tending to be solitary and to have 0–3 basal leaves ..... 4. *S. marilandica*

Ovary or fruit on a short stalk; calyx-segments cleft about ½ distance to top of ovary, triangular-ovate, acute or obtuse, membranous; petals yellow, much longer than calyx-segments; old staminate flowers on pedicels 1.5–2 mm. long and shorter than mature fruits; plants tending to be clustered and to have several basal leaves. 5. *S. gregaria*

1. *Sanicula canadensis* L. (*S. floridana* Bickn.; *S. canadensis* var. *floridana* [Bickn.] H. Wolff) Canada Sanicle, Short-styled Snakeroot.

Plants biennial, up to 13 dm. tall; roots fibrous to slightly fleshy; leaves trifoliate with basal blades deeply cut; basal leaves 0–3; cyme usually compounded 3–4 times; umbels with 3–8 flowers, usually 3 perfect and 2 staminate; petals white or greenish, shorter than calyx-segments; bristles of fruit (when young) bent over into secondary areas so that they appear in 8 rows; fruit (Fig. 4) 2–5 mm. long, almost orbicular; seed sulcate under oil-tubes.—Native. Flowers from spring to fall.

Sanicula canadensis var. *floridana* (Bickn.) Wolff (*S. floridana* Bickn.) is a variant from the typical species, but no attempt has been made to distinguish them here. There is a considerable amount of intergradation. This variant is rarely seen on the coastal plain of North Carolina. It is a smaller plant with thicker leaf blades and stiffer bristles on the teeth.

DISTRIBUTION: Common in woods and along streams; mts., pied., and coastal plain. Fla. to Tex., north to Vt., Ont. (Macoun 53985; NY), and Wyo. (Williams 190; NY); in Southeast (Map VI), all states.

SPECIMENS CITED: ALABAMA: Clay, Mohr, July 30, 1896 (US); Hale, Harper 3063 (NY, US); Jackson, Harbison 4471 (NCU); Lee, Pollard & Maxon 38 (US); Madison, Pollard & Maxon 379 (NY, US); Mobile, Mohr, June, 1896 (US). FLORIDA: Alachua, O'Neill 642 (US); Clay, Arnold & West, July 15, 1947 (FLA); Columbia, Rose 2244 (FLA, NCU, NY, PH, US); Duval, Fredholm 5285 (US); Hernando, Davis, July 18, 1934 (FLA); Jackson, Arnold & West, May 7, 1948 (FLA); Lake, Marsh 988 (NY, US); Leon, Kurz, Aug. 31, 1942 (FLA); Levy, Murrill, April 23, 1939 (FLA); Liberty, Beck, July 23, 1947 (FLA); Marion, Blake, April 2, 1950 (FLA); Volusia, Hood, June 27, 1910 (FLA); Walton, Hume, June 7, 1938 (FLA). GEORGIA: Chatham, Eyles 4638 (DUKE); Clarke, Pyron, July 5, 1929 (DUKE); Columbia, Duncan 9741 (GA, NCU); DeKalb, Small, July 25, 1893 (NY, US); Early, Harper 1221½ (NY); Floyd (?), Chapman 2197 (US); Fulton, Duncan 9595 (GA); Houston, Ainsworth, June 25, 1944 (PH); Jefferson, Hopkins 29 (NY); Lincoln, Duncan 9821 (GA, NCU); Oglethorpe, Cronquist 4581 (GH); Rabun, Radford, June 20, 1946 (NCU); Richmond, Cuthbert, Aug. 11, 1907 (NY); Sumter, Harper 1042 (NY). LOUISIANA: Calcasieu, Allison 144 (NY, US); Rapides, Correll 9859 (DUKE, PH); St. Tammany, Arsene 11865 (US). MISSISSIPPI: Harrison, Pollard 1050 (US); Jackson, collector unknown, June 1896 (NY); Jasper, Tracy 3320 (NY). NORTH CAROLINA: So common throughout the state that citations of county records (73) are omitted to save space. SOUTH

CAROLINA: Aiken, Radford 546 (NCU); Anderson, Gibbes, 1886 (NY); Berkeley, Godfrey & Tryon 142 (DUKE, NY, PH, TENN, US); Charleston, Hunt & Martin 156 (CLEMS); Clarendon, Godfrey & Tryon 995 (DUKE); Darlington, Smith 1481 (NCU); Georgetown, Godfrey & Tryon 109 (NY, US); Greenville, Thakston, July, 1920 (FUR); Horry, Powell, June 22, 1937 (FUR); Lexington, McGregor 253 (US); Marlboro, Radford & Stewart 413 (NCU); Oconee, collector unknown, July 2, 1897 (NY); Orangeburg, Godfrey & Tryon 796 (NY, US); Pickens, House 3497 (NY). TENNESSEE: Bradley, Benner 5811 (PH); Chatham, Svenson 10392 (DUKE, PH, US); Cocke, Kearney 709 (US); Davidson, Bicknell 6702 (NY); Grainger, Morrison & Brown 16 (TENN); Knox, Kearney, July 9, 1894 (NY, US); Maury, Svenson 9048 (DUKE); Rutherford, Quarterman 1669 (DUKE); Unicoi, Price 864 (DUKE); Union, Kalter, June 16, 1936 (TENN); Van Buren, Ford & Russell 1993 (TENN); Warren, Svenson 9384 (DUKE).

2. *Sanicula trifoliata* Bickn. Large-fruited Snakeroot.

Plants biennial, up to 9 dm. tall; roots fibrous; leaves trifoliate, the basal leaflets often deeply cut; calyx-segments subulate, curving inward slightly; petals white; fruits 6–8 mm. long; oil-tubes small and numerous, sometimes with 2 large lateral ones.—Native. Flowers from spring to fall.

DISTRIBUTION: Woods. N. C. and Tenn., north to Vt., Ind., and Ont.; in Southeast (Map VI), N. C. and Tenn.

SPECIMENS CITED: NORTH CAROLINA: Clay, Wilbur 1265 (DUKE); Mitchell, Cannon 101 (NY). TENNESSEE: Davidson, Svenson 88 (NY, PH); Sevier, Cain, June 13, 1937 (TENN).

3. *Sanicula smallii* Bickn.

Plants perennial, up to 6 dm. tall; roots fleshy; stems seldom branching except at top; leaves thickish, trifoliate with basal blades deeply cut; cyme usually compounded 1–3 times; flowers usually 3 perfect and 2–8 staminate to an umbel; calyx-segments subulate; petals greenish-white, shorter than calyx-segments; fruits 3–5 mm. long, about orbicular; oil-tubes 5, large; seed sulcate under oil-tubes.—Native. Flowers from spring to fall.

DISTRIBUTION: Deciduous woods; mts., pied., and coastal plain. Fla. to Tex., north to Va. and Mo.; in Southeast (Map VI), all states.

SPECIMENS CITED: ALABAMA: Clarke, Mohr, April 24, 1888 (US); Lee, Earle, May 1, 1896 (NY); Madison, Pollard & Maxon 377 (US); Tuscaloosa, Smith, 1877 (US); Walker, Earle, June 19, 1899 (NY). FLORIDA: Gadsden, Kincaid & West, April 18, 1930 (FLA); Leon, Nash 2362 (NCU); Liberty, O'Neill 566 (US). GEORGIA: Burke, Leeds & Harper 2760 (PH); Clarke, Harper 143 (NY, US); Columbia, Duncan 9510 (GA, NCU); De Kalb, Small, July 25, 1892 (US); Floyd, Chapman, no number or date (US); Gordon, Leeds 2124 (PH); Richmond, Cuth-

bert, May 15, 1904 (FLA). LOUISIANA: Natchitoches, Palmer 7513 (NY, US). MISSISSIPPI: County unknown, Clute 94 (NY). NORTH CAROLINA: Alamance, Totten et al., May 22, 1937 (NCU); Anson, Rodgers 777C (GA, NCU); Burke, Rodgers 729C (DUKE, NCU); Cabarrus, Rodgers 768C (NCU); Caldwell, Small & Heller 338 (US); Durham, Blomquist 4409 (DUKE); Forsyth, Rodgers 781C (NCS, NCU); Jackson, Rodgers 602C (NCU); Johnston, Fox & Godfrey 1661 (NCS); McDowell, Rodgers 717C (NCU); Orange, Rodgers 250C (NCU); Polk, Churchill, May 29, 1899 (TENN); Randolph, Rodgers 439C (NCU, US); Rutherford, Rodgers 733 (NCU); Stanly, Small & Heller, Aug. 8, 1891 (NY); Wake, Wells, June 30, 1942 (NCS); Warren, Rodgers 412C (NCU, NY, US); Wilkes, Rodgers 793C (DUKE, NCU). SOUTH CAROLINA: Abbeville, Branch, 1855 (NY); Greenville, Batson, May 31, 1934 (FUR); Richland, Philson, May 18, 1936 (DUKE). TENNESSEE: Cocke, Kearney 710 (NY, US); Hamilton, Bicknell, June 21, 1894 (NY); Jackson (?), Bain 302 (NY); Knox, Bain, April 30, 1933 (TENN); Loudon, Cain & Sharp 4505 (TENN); Montgomery, Clebsch, April 27, 1946 (TENN).

4. *Sanicula marilandica* L. (*S. marilandica* var. *petiolulata* Fern.) Black Snakeroot.

Plants perennial, up to 13 dm. tall; roots fibrous, black; leaves 3- or 5-foliate with basal blades deeply cut; basal leaves 0–3; cyme usually compounded 2–3 times; umbel with few to 40 flowers, spherical, usually 3 perfect flowers and numerous staminate ones, some umbels completely staminate; calyx-segments subulate; petals greenish-white, equal or longer than calyx-segments; fruits 4–6 mm. long, nearly orbicular; oil-tubes 5, large; seed sulcate under oil-tubes.—Native. Flowers from spring to fall.

DISTRIBUTION: Woods; mts., pied., and coastal plain. Fla. to N. M., north to Newf. and B. C.; in Southeast (Map VI), all states except Miss. (reported) and La. (probably present).

SPECIMENS CITED: ALABAMA: Lee, Earle 197 (US). FLORIDA: Alachua, Arnold & West, April 4, 1939 (FLA); Gadsden, Kincaid & West, April 18, 1930 (FLA); Madison, Murrill, 1940 (FLA). GEORGIA: Cobb, Harper 224 (US); Early, Harper 1908 (US); Grady, Cronquist 5459 (FLA, GH); Rabun, Small, Aug. 4, 1893 (NY); Richmond, McCarthy, June, 1888 (US). LOUISIANA: None. MISSISSIPPI: Reported by Lowe. NORTH CAROLINA: Ashe, Rodgers 809C (NCU); Buncombe, Biltmore Herb. 882a (NCU); Burke, Ashe, no number or date (NCU); Clay, Rodgers 613C (NCU); Craven, reported by Coom; Dare, Fox & Godfrey 2318 (NCS); Durham, Blomquist 4414 (DUKE); Forsyth, Schallert 8572 (DUKE); Gaston, Rodgers 743C (NCU); Johnston, collector and date unknown (NY); Mecklenburg, Rodgers 745C (NCU); Mitchell, reported by Gray; New Hanover, reported by Wood & McCarthy; Orange, Rodgers 249C (NCU); Pender, Godfrey 6583 (NCU); Polk, Peattie 1191 (NCU); Stanly, reported by Small & Heller; Wake, Godfrey 3943 (DUKE); Watauga, reported by Small & Heller. SOUTH CAROLINA:

Aiken, Ravenel, Sept., 1869 (US); Charleston, Moldenke 1194 (DUKE); Darlington, Rodgers, April 3, 1910 (NCU); Florence, Bartram 2304 (PH); Pickens, Rodgers 338 (DUKE). TENNESSEE: Cocke, Kearney 708 (NCU, US).

5. *Sanicula gregaria* Bickn. Clustered Sanicle, Clustered Snakeroot.

Plants perennial, up to 9 dm. tall; roots fibrous, black; leaves thin, bright-green, trifoliate with basal blades deeply cut; basal leaves usually several; cyme compounded up to 4 times; umbels spherical with few to 30 flowers, usually 3 perfect and several staminate, some umbels entirely staminate; calyx-segments thin, triangular to ovate, acute or obtuse; petals yellow, longer than calyx-segments; fruit orbicular to obovoid, 3–5 mm. long, with widely spaced bristles; oil-tubes 5, large; seed not sulcate under oil-tubes.—Native. Flowers from spring to fall.

DISTRIBUTION: Low, damp woods; mts., pied., and coastal plain. Fla. to La., north to Que. and S. D.; in Southeast (Map VI), all states except Miss. (probably present).

SPECIMENS CITED: ALABAMA: Hale, Harper 3063 (PH); Marshall, Harper 3350 (PH, US); Montgomery, Harper 84 (US). FLORIDA: Calhoun, Oosting 106 (DUKE); Gadsden, Arnold & West, March 14, 1937 (DUKE); Jackson, Knight, April 5, 1944 (FLA). GEORGIA: Early, Harper 1221 (US); Rabun, Duncan 9559 (GA, NCU); Randolph, Harper 1887 (US); Richmond, Cuthbert, no number or date (FLA); Whitfield, Harper 256 (US). LOUISIANA: Feliciana (East or West ?), Carpenter, April, 1840 (US). MISSISSIPPI: None. NORTH CAROLINA: Buncombe, Biltmore Herbarium 4816 (US); Cabarrus, Rodgers 769C (DUKE, GA, NCS, NCU); Cherokee, Jennison 589 (TENN); Durham, Anderson 6282 (FLA, PH); Guilford, Rodgers 371C (DUKE, NCS, NCU); Halifax, Williamson, April 19, 1908 (PH); Haywood, Blomquist 4413 (DUKE); Henderson, reported by Memminger; Jackson, Radford, June 26, 1946 (NCU); Macon, Ashe, May 24, 1893 (NCU); Mitchell, Cannon, July 16, 1902 (US); Orange, Totten, May 13, 1936 (NCU); Polk, Peattie 2206 (NCU); Watauga, Ashe, May 23, 1893 (NCU). SOUTH CAROLINA: Charleston, Hunt 2246 (CLEMS); Oconee, House 2126 (US); Richland, Philson, April 23, 1936 (DUKE). TENNESSEE: Knox, Lamson-Scribner, May 10, 1890 (US); Lewis, King 70 (DUKE); Sevier, Drew, May 16, 1937 (TENN); Shelby, Sharp, Felix, & Adams 12002 (TENN); Sullivan, Jennison, Sharp, & Underwood 818 (TENN).

5. DAUCUS L. Carrots.

Pubescent (rarely glabrous), erect, simple or branching annuals and biennials. Taproots. Leaves pinnately decompound. Umbels compound, opposite leaves. Bracts simple to pinnately decompound; bractlets simple, ternate, or pinnate. Flowers tending to be irregular. Calyx-teeth absent or distinct. Petals white (less commonly yellowish, pink, or purple), spreading, recurved at tip. Stylopodium conic. Ovary bristly. Fruit almost terete or slightly laterally flattened; primary

ribs bristly; secondary ribs toothed, their tips usually barbed. Carpophore usually entire. Oil-tubes solitary under secondary ribs. Seed dorsally flattened, face slightly concave.

Bracts mostly pinnately decompound, spiny-hispid; bractlets simple, linear, and mostly entire; outside rays usually less than 30 mm. long; central flower of central umbelet like the others; teeth with caps of barbs at their apexes ..... 1. *D. pusillus*

Bracts pinnately divided, 3-parted, or rarely simple; bractlets simple to pinnate; outside rays mostly over 35 mm. long; central flower of central umbelet often rose or purple colored; teeth with one or two inconspicuous barbs at apex or barbs absent . . 2. *D. carota*

1. *Daucus pusillus* Michx. Dwarf Carrot, American Carrot.

Annual plants up to 10 dm. tall, sparingly branched; flowers white; stamens about length of petals; styles shorter than petals; fruit ovoid to ellipsoid; teeth of secondary ribs usually about 8 to a row.—Native weed. Flowers from spring to fall.

DISTRIBUTION: Waste-places; chiefly coastal plain. Fla. to N. C., west to Tex., Kans., Mex., Calif., and up west coast to B. C., in Southeast (Map V), all states; in N. C., southeast corner of state.

SPECIMENS CITED: ALABAMA: Baldwin, Schallert 527 (DUKE); Mobile, Mohr, June, 1883 (US); Wilcox, Nuttall, May, 1893 (NY). FLORIDA: Alachua, Weber, June 7, 1928 (FLA); Citrus, Small 10389 (US); Columbia, Rolfs 143 (FLA); Duval, Curtiss 6164 (NCU); Escambia, Blanton 6571 (US); Gadsden, Foster, June 2, 1936 (FLA); Liberty, Chapman 375 (US); Union, West & Arnold, May 22, 1942 (FLA); Wakulla, Moldenke 1121 (DUKE, NY); Walton, Small, summer, 1885 (NY). GEORGIA: Jenkins, Harper 758 (GH, NY, US); Decatur, Small, June 4, 1895 (NY); De Kalb, Eggert, May 23, 1897 (NY); Thomas, O. E.—, June 11, 1945 (FLA). LOUISIANA: Orleans, Drummond, 1832 (GH); Rapides, Ball 392 (GH, NY, US); St. Landry, Carpenter, no number or date (PH); St. Martin, Langlois, May 9, 1893 (US); St. Tammany, Arsene 11838 (US). MISSISSIPPI: Jasper, Tracy 3315 (NY); Madison, McDougall 1353 (US). NORTH CAROLINA: Brunswick, Rodgers 284AC (NCU, NY, US); Craven, Rodgers 338AC (NCU, NY, US); New Hanover, Rodgers 301C (DUKE, GA, NCS, NCU, NY); Pender, A. C. W., May 21, 1925 (NCS). SOUTH CAROLINA: Aiken, Ravenel, 1870 (NY); Beaufort, Cuthbert, May, 1883 (FLA); Berkeley, Ravenel, May,— (GH); Charleston, Hunt 1555 (CLEMS); Clarendon, Stone 550 (PH); Florence, Bartram, May 17, 1912 (PH); Lexington, McGregor 46 (US); Oconee, collector unknown, June 24, 1897 (NY); Pickens, collector unknown, July 7, 1897 (NY); Richland, Taylor (US); Sumter, Bartram, May 17, 1912 (PH). TENNESSEE: Davidson, Svenson 9076 (GH).

2. *Daucus carota* L. Wild Carrot, Bird's nest, Crow's-nest, Queen Anne's Lace, Lace-flower, Rantipole, Devil's Plague.

Plants annual or biennial, up to 15 dm. tall; flowers white, pink, yellowish, or purple; outer flowers often distinctly radiant; central flower or central umbe-

let at times partially or entirely purple; stamens mostly longer than petals; styles shorter than petals; fruit (Fig. 5) ellipsoid or oblong; teeth of secondary ribs usually over 10 to a row.—Introduced weed. Flowers from spring to fall.

This weed has spread rapidly since its introduction. It is an interesting fact that in the Southeast it does not occur as abundantly within the range of *D. pusillus* as it does farther north. It is not known whether the climate is not suitable or whether it has not yet reached its maximum spread.

DISTRIBUTION: Almost anywhere, but most abundant in waste places. Throughout N. A.; in Southeast (Map V).

SPECIMENS CITED: ALABAMA: Jackson, Porter, June 13, 1938 (GH); Mobile, Zimmer, June, 1884 (US). FLORIDA: Jefferson, Burger, Sept. 19, 1927 (FLA); Volusia, Butts, Aug., 1943 (GH). LOUISIANA: None. MISSISSIPPI: Reported by Brown. NORTH CAROLINA: So common throughout the state that citations of county records (80) are omitted to save space. Specimens have not been seen from the following counties (all in the coastal plain, especially in southeastern corner): Bladen, Brunswick, Carteret, Columbus, Cumberland, Duplin, Greene, Hoke, Hyde, Johnston, Jones, Lenoir, New Hanover, Onslow, Pender, Perquimans, Pitt, Robeson, Sampson, and Wayne. SOUTH CAROLINA: Darlington, Smith 593 (NCU); Greenville, Powell, May 27, 1931 (FUR); Oconee, Rosenkrans & Rice, June 8, 1926 (CLEMS). TENNESSEE: Carter, Brown 90 (DUKE); Knox, Totten (NCU); Obion, Eyles 8399 (GH); Unicoi, Price 737 (DUKE).

6. TORILIS Adans.

Pubescent, erect or spreading annuals. Taproots. Leaves pinnate or pinnately decompound. Umbels open or compact, opposite leaves. Bracts absent or simple; bractlets simple. Flowers irregular. Calyx-teeth distinct or obsolete. Petals white, spreading, recurved at tips. Stylopodium conic. Ovary and fruit laterally flattened, bristly or tuberculate. Carpophore split from ⅓ to ½ distance from apex. Oil-tubes solitary under secondary ribs, 2 on commissure. Seed slightly dorsally flattened, face concave or sulcate.

Inflorescence a distinct umbel, regular.....1. *T. japonica*
Inflorescence compact, irregular.....2. *T. nodosa*

1. *Torilis japonica* (Houtt.) D. C. (*T. anthriscus* C. C. Gmel.) Erect Hedge Parsley, Rough Chervil, Hemlock Chervil, Rough Cicely.

Plants erect, appressed-hispid, up to 12 dm. tall; leaves decompound; leaflets toothed or deeply lobed; peduncles longer than the leaves they oppose, rays 3–10, up to 3.5 cm. long; bracts absent or 1–several, simple; bractlets longer than pedicels, subulate; fruit (Fig. 6) ellipsoid, 1.5–4 mm. long, covered with uncinate, glochidiate bristles. Introduced weed. Flowers in spring and summer.

This plant was probably introduced to North Carolina in seeds used for planting on road shoulders. Both known locations are in adjacent counties. A

large stand at Morrow Mt. State Park was along the edge of the recently developed parking area.

DISTRIBUTION: Waste-places. Known from Ala., Calif., D. C., Ill., Ind., Kans. (Horr E90; GH), Ky., Mo., N. C., N. J., N. Y., Ohio, Ore., Penn., Tenn., Tex., and Va.; in Southeast (Map V), Ala., Tenn., and N. C.

SPECIMENS CITED: ALABAMA: Jefferson, Harper 3676 (GH, NY); Marshall, Harper 3587 (NY, US). NORTH CAROLINA: Montgomery, Radford & Rodgers 459C (DUKE, GA, NCS, NCU, NY, US); Stanly, Rodgers 583C (NCU). TENNESSEE: Davidson, Svenson 7080 (GH); Marion, Sharp & Underwood 2553 (TENN); Rutherford, Quarterman, June 21, 1947 (DUKE).

2. *Torilis nodosa* (L.) Gaertn. Knotted Hedge Parsley.

Plants spreading, appressed-hispid, up to 6 dm. tall; leaves decompound, the ultimate divisions mostly linear; peduncles absent or much shorter than the leaves they oppose; rays absent or very short; bracts absent or 1–2, simple; bractlets longer than pedicels, linear; fruit ellipsoid to ovoid, the outside ones usually having one mericarp armed with uncinate, glochidiate bristles and the other warty, the inside fruits warty.—Introduced weed. Flowers in spring and summer.

DISTRIBUTION: Waste-places. Known from Ala., Calif., Ga., La., N. C., Ore., Penn., S. C., and Tex.; in Southeast (Map V), Ala., Ga., La., N. C., and S. C.

SPECIMENS CITED: ALABAMA: Montgomery, Harper 17 (GH, NY, PH, US). GEORGIA: Richmond, Biltmore Herb. 7594a (US). LOUISIANA: Plaquemines, Langlois, 1885 (NY). NORTH CAROLINA: Carteret, Blomquist & Batson 14975 (DUKE, NCS). SOUTH CAROLINA: Beaufort, Churchill 623 (GH).

7. SCANDIX L.

Pubescent, erect, branching annuals. Taproots. Leaves pinnately decompound. Umbels simple or compound, opposite leaves. Bracts absent in compound umbels; bractlets present. Flowers irregular, perfect and staminate. Calyx-teeth obsolete. Petals white, spreading, recurved at tip. Stylopodium low, conic. Ovary elongate, slender-beaked above, ribbed, strigose on body and margin of beak. Carpophore entire or nearly so. Oil-tubes solitary between ribs or absent. Seed slightly dorsally flattened, face deeply sulcate (Fig. 7).

1. *Scandix pecten-veneris* L. Venus' Comb, Lady's Comb, Shepherd's Needle.

Plants up to 5 dm. tall; leaf divisions linear, acute; umbels simple, usually 2 together or compound with 2 rays; bractlets (bracts of simple umbel) with ciliate margins, usually 2-lobed at apexes, but may be entire to pinnate; perfect and staminate flowers in same umbelet or separate; styles short; fruit (Fig. 7) up to

7 cm. long with beak 5–7 times longer than body, beak dorsally flattened.—Introduced weed.

DISTRIBUTION: Waste-places. Known from Ala., N. C., D. C., Penn., N. J., Tex., Calif., Ore., and B. C.

SPECIMENS CITED: ALABAMA: Mobile, Mohr, June, 1885 (US). NORTH CAROLINA: Durham, Blomquist 13453 (DUKE); Iredell, Hyams, June, 1898 (US); Mecklenburg, Phillipps, no number or date (NCS); Wake, Wells, May 10, 1949 (NCS).

8. OSMORHIZA Raf. Sweet Cicelies.

Pubescent to glabrous, branching perennials. Roots clustered, somewhat fleshy. Leaves 2- or 3-ternate or ternate-pinnate; blades broad. Umbels compound, opposite leaves. Bracts few and foliaceous or absent; bractlets several to absent. Flowers regular, perfect and staminate. Calyx-teeth obsolete. Petals white, purplish, or yellow, recurved at tips. Stylopodium conic. Ovary and fruit elongate, laterally flattened, filiform-ribbed. Carpophore split at top. Oil-tubes small or absent. Seed subterete, face deeply sulcate (Fig. 8).

Style and stylopodium together in flower less than 1 mm. long, shorter than petals, in fruit less than 1.5 mm. long ..... 1. *O. claytoni*
Style and stylopodium together in flower 1.5–2.5 mm. long, longer than petals, in fruit 3–4 mm. long ..... 2. *O. longistylis*

1. *Osmorhiza claytoni* (Michx.) Brit. (*O. brevistylis* D. C.) Woolly or Hairy Sweet Cicely, Sweet Jarvil.

Plants up to 10 dm. tall; stem with soft, long pubescence or rarely glabrous; leaf blades thin, ovate or lanceolate, coarsely serrate, some incised; umbels fairly symmetrical in flower, but highly asymmetrical in fruit; rays 2–5; ovary and fruit elongate, strigose on base and ribs; fruits clavate or oblong-clavate, about 15–24 mm. long.—Native. Flowers in spring.

DISTRIBUTION: Deep woods; pied. and mts. in this area. N. C. and Ala., north to N. S., Que., and Man.; in Southeast (Map III), Ala., N. C., and Tenn.

SPECIMENS CITED: ALABAMA: Jackson, Harbison 4580 (NCU); Franklin (?), Baker, May 23, 1897 (NY, US); Madison, Baker, May 23, 1897 (NY). NORTH CAROLINA: Avery, Hunnewell 917 (GH); Caldwell, collector unknown, June 28, —— (NCU); Haywood, Holmes, Aug., 1903 (NCU); Jackson, Radford, May 29, 1947 (NCU); Macon, Radford 5255 (NCU); McDowell, Radford 5298 (NCU); Mitchell, Ashe, June 26, 1893 (NCU); Moore, Radford, 1950 (NCU); Polk, Peattie 2183 (NCU); Swain, Oosting 35259 (DUKE); Watauga, Radford 258C (NCU). TENNESSEE: Blount, Kinsey, May 1, 1932 (TENN); Davidson, Quarterman 1207 (DUKE); Knox, Sharp & Hesler 584 (TENN); Sevier, Sharp 646 (TENN); Unicoi, Price 939 (DUKE).

2. *Osmorhiza longistylis* (Torr.) D. C. (*O. longistylis* var. *villicaulis* Fern.) Smoother sweet Cicely, Sweet Anise, Anise-root, Sweet Chervil, Sweet Jarvil, Cicely root.

Plants up to 10 dm. tall; roots with anise odor; stems glabrous to densely villous; leaf blades thin, ovate or lanceolate, coarsely serrate, some incised; umbels fairly symmetrical in flower, but highly asymmetrical in fruit; rays 1–6; ovary and fruit elongate, strigose on base and ribs; fruit clavate or oblong-clavate, about 15–20 mm. long.—Native. Flowers in spring.

Varieties of this species have been described on the basis of degree of pubescence of stem. Because of the impossibility of drawing dividing lines, it seems best to consider the whole population as variable in this character.

DISTRIBUTION: Rich woods; Chiefly pied. and mts. in this area. Ga. to Tex., north to Que. and Alb.; in Southeast (Map III), Ga., Ala., N. C., and Tenn.

SPECIMENS CITED: ALABAMA: Tuscaloosa, Ward, April, 1892 (US); Walker, Harper & Morgan, April 30, 1941 (GH, US). GEORGIA: North Georgia, Vasey, 1876 (US); also, reported by Constance & Shan (Pyron & McVaugh 2494; GA). NORTH CAROLINA: Buncombe, Biltmore Herb. 674b (US); Chatham, Coker, Apr. 24, 1938 (NCU); Durham, Oosting 3318 (DUKE, PH); Mitchell, Ashe, June 26, 1893 (NCU); Orange, Browne, 1949 (NCU); Swain, Jennison 711 (TENN); Watauga, reported by Small & Heller. TENNESSEE: Davidson, Gattinger, June 28, 1886 (US); Decatur, Sharp, Felix, & Adams 12801 (TENN); Dyer, Sharp et al. 12233 (TENN); Knox, Ruth 429 (US); Louderdale, Sharp et al. 12130 (TENN); Loudon, Cain & Sharp 4506 (TENN); Obion, Eyles 7733 (GH); Tipton, Sharp et al. 12155 (TENN).

9. CHAEROPHYLLUM L. Chervils.

Glabrous or pubescent, branching, erect or ascending annuals or biennials. Taproots or tuberous roots. Leaves decompound. Umbels compound or simple, opposite leaves. Bracts absent in compound umbels, present in simple ones; bractlets present. Flowers perfect, regular. Calyx-teeth obsolete. Petals mostly white, spreading. Stamens and styles usually equal or shorter than petals. Stylopodium conic. Ovary and fruit elongate, laterally flattened; fruit ribbed. Carpophore split almost half way to base. Oil-tubes solitary between ribs, 2 on commissure. Strengthening cells conspicuous in primary areas. Seed subterete, face deeply sulcate.

Fruit contracted into a beak at its apex; ribs usually wider than the intervals between them; body of fruit usually 2 mm. or less wide; plants densely to sparingly hispid; ultimate segments of leaves acute and obtuse; bracts (bractlets if umbel compound) longer than shortest pedicels of mature fruits ..... 1. *C. tainturieri*

Fruit not beaked at apex; body of fruit usually 2 mm. or more wide; plants glabrous or sparingly pubescent; ultimate segments of leaves mostly obtuse; all bracts (bractlets if umbel compound) shorter than pedicels of mature fruits ..... 2. *C. procumbens*

1. *Chaerophyllum tainturieri* Hook. (*C. tainturieri* var. *floridanum* C. & R.; *C. floridanum* [C. & R.] Bush) Tainturier's Chervil.

Plants mostly erect, up to 9 dm. tall, hispid, especially at base; umbels usually simple, 1–4 at a node, if compounded, peduncles up to 5 cm.; petals not recurved at tips; ovary and fruit (Fig. 9) twice or more longer than wide, glabrous. —Native weed. Flowers in spring.

A variety of this species with pubescent fruits ranges from Ala. to Tex.

DISTRIBUTION: Waste-places; mts., pied., and coastal plain. Fla. to Tex., north to Va., Ind., and Kans.; in Southeast (Map IV), all states.

SPECIMENS CITED: ALABAMA: Hale, Harper 3196 (GH, PH); Choctaw, Mohr, May 16, 1898 (US); Lee, Earle & Baker, April 9, 1898 (US); Mobile, Mohr, April, 1879 (US); Tuscaloosa, Ward, April 7, 1892 (US). FLORIDA: Alachua, West, April 14, 1933 (FLA); Duval, Curtiss 4653 (GH, PH, US); Jackson, Biltmore Herb. 1912a (US); Leon, Kurz, May, 1943 (FLA); Manatee, Tracy 7442 (GH, PH, US); St. Johns, Curtiss 6134 (FLA, NCU); Volusia, Fuller, April 9, 1904 (GH); Washington, Plas, July 3, 1941 (FLA). GEORGIA: Baldwin, Duncan 1376 (FUR, PH); Clarke, Pyron, March 15, 1930 (DUKE); Cobb, Larrabee, May 3, 1885 (GH); De Kalb, Curtiss 6777 (GH, US); Dougherty, Thorne & Muenscher 2436 (US); Elbert, Duncan 9429 (GA, NCU); Fulton, Knowlton, April 20, 1905 (GH); Richmond, Cuthbert, April 1–23, 1904 (FLA). LOUISIANA: East Baton Rouge, Billings 46 (GH); Jefferson, Ball 314 (GH, NY, US); Natchitoches, Palmer 7488 (NY); Orleans, Meredith, April, 1916 (PH). MISSISSIPPI: Attala, McDougall 1245 (US); Hinds, Phares 2 (US); Oktibbeha, Tracy 1350 (US); Washington, Barnhart 2829 (NY). NORTH CAROLINA: Alamance, Rodgers 366C (NCU); Brunswick, Rodgers 318C (NCU); Columbus, Rodgers 272C (NCU); Craven, Rodgers 342AC (NCU); Cumberland, Rodgers 167C (GA, NCS, NCU); Durham, Rodgers 248C (NCU); Greene, Rodgers 845C (NCU); Guilford, Rodgers 372C (NCU); Halifax, Bartram(?), April 19, 1909 (PH); Harnett, Rodgers 121C (NCU, NY, US); Johnston, Rodgers 343C (NCU); Montgomery, Rodgers 461C (NCU); New Hanover, Oosting 3565 (DUKE, NY); Orange, Rodgers 19C (NCU); Pamlico, Rodgers 233AC (NCU); Pender, Rodgers 133C (NCU); Perquimans, Rodgers 552C (NCU); Pitt, Woods, May 9, 1949 (NCS); Polk, Peattie 1872 (NCU); Randolph, Rodgers 441C (NCU); Robeson, Rodgers 339C (NCU); Stanly, Kirk 41 (NCU); Tyrrell, Rodgers 513C (NCU); Vance, Fernald & Long 7919 (GH, NY, US); Wake, Rodgers 361C (NCU); Wayne, Rodgers 196C (NCU); Wilson, Rodgers 356C (NCU). SOUTH CAROLINA: Aiken, Ferguson, April 5, 1922 (NY); Anderson, Davis, April 5, 1920 (US); Beaufort, Churchill 612 (GH); Charleston, Hunt 220F (CLEMS); Colleton, Williamson, April, 1894 (PH); Darlington, Norton, April 29, 1921 (NCU); Greenville, Peattie, May 1, 1931 (FUR); Lexington, McGregor 519 (NCU); Oconee, Rosenkrans, April 29, 1930 (CLEMS); Richland, Crawford, June, 1891 (US). TENNESSEE: Anderson, Jennison 217 (TENN); Bedford, Montgomery, May 8, 1894 (GH, US); Blount, Jones 512 (TENN); Carroll, Sharp et al. 12148 (TENN); Davidson, Hubbard 1039 (US); Dyer, Sharp et al. 12208 (TENN); Fayette,

Sharp et al. 10363 (TENN); Franklin, Sharp et al. 10712 (TENN); Giles, Sharp et al. 10961 (TENN); Hamilton, Beckwith 930 (US); Haywood, Bain 413 (GH, NY); Henry, Sharp et al. 13065 (TENN); Knox, Sharp & Hesler 165 (TENN); Lewis, Sharp et al. 11911 (TENN); Montgomery, Shanks 1791 (TENN); Polk, Sharp et al. 10501 (TENN); Rutherford, Eggert, May 4, 1898 (US); Shelby, Moore T354 (TENN); Sumner, Deam, May 10, 1941 (DUKE); Wilson, Pennell 11378 (PH).

2. *Chaerophyllum procumbens* (L.) Crantz Spreading Chervil.

Plants tending to spread, up to 9 cm. tall; umbels simple, usually 2–3 from a node, or compound with slender peduncles; ovary and fruit twice or more longer than wide, glabrous.—Native weed. Flowers in spring.

This species' range is mostly north of N. C., but two collections are known from S. C., five from Tex., and one from Ala. No collection is yet known from this state.

DISTRIBUTION: Waste-places. S. C., Ala., Ark., and Kans., north to N. Y. and Ont.; in Southeast (Map IV), S. C., Ala., and Tenn.

SPECIMENS CITED: ALABAMA: Colbert, Harper, April 27, 1943 (US). MISSISSIPPI: Reported by Lowe. NORTH CAROLINA: Reported by Hyams. SOUTH CAROLINA: Charleston (?), Blackman, no number or date (PH); Chesterfield, Williamson, April 9, 1898 (PH). TENNESSEE: Davidson, Quarterman 769 (DUKE); Hardin, Felix et al. 10141 (TENN); Knox, Ruth 2859 (NY); Marshall, Sharp et al. 11202 (TENN); Rutherford, Sharp et al. 11820 (TENN).

10. CRYPTOTAENIA D. C.

Glabrous, erect, branching perennials. Taproots and fibrous roots. Leaves trifoliate. Umbels compound, asymmetrical, opposite leaves. Bracts absent or solitary; bractlets absent or 2–3. Flowers regular, perfect and staminate. Calyx-teeth absent to small. Petals white, recurved at tips. Stylopodium conic. Ovary and fruit elongate and laterally flattened; fruit ribbed. Carpophore split to base. Oil-tubes 1–4 between the ribs, 2 on commissure. Seed subterete.

1. *Cryptotaenia canadensis* (L.) D. C. (*Deringa canadensis* [L.] Kuntze) Honewort.

Plants up to 12 dm. tall; leaflets thin, ovate, elliptic, or lanceolate, acute at apexes, doubly serrate (tips of teeth acute to acuminate); terminal leaflets with cuneate-serrate bases; basal leaflets often deeply cut; sheath of leaves with hyaline margins; rays 1–7, very unequal; umbelets with 10 or fewer pedicels, very unequal, pedicels bearing staminate flowers much shorter; stamens slightly longer than petals; ovary almost twice as long as wide, smooth; fruit (Fig. 10) twice as long as wide or longer; ribs primary, alike.—Native. Flowers in spring and summer.

DISTRIBUTION: Wooded or open bottomland and hardwood forests; chiefly pied. and mts. Ga. to Tex., north to N. B., Que., and Man.; in Southeast (Map III), all states except Fla. (reported in Miss.).

SPECIMENS CITED: ALABAMA: Coosa, Earle, Aug. 29, 1897 (NY); Tuscaloosa, Harper 3073 (GH, NY). FLORIDA: None. GEORGIA: Cherokee, Duncan 8331 (FLA); Clarke, Pyron, July 13, 1929 (DUKE); Early, Harper 1228 (GH, NY, US); Lincoln, Duncan 9826 (GA); Richmond, Cuthbert, July 27, 1900 (NY); Whitfield, Harper 249 (GH, NY, US). LOUISIANA: East Baton Rouge, Brown 2805 (GH); Feliciana (East or West ?), Carpenter, June, 1890 (US); Rapides, Hale, no number or date (NY). MISSISSIPPI: Reported by Lowe. NORTH CAROLINA: Alamance, Oosting 33538 (DUKE); Buncombe, Rodgers 707C (GA, NCU); Cabarrus, Rodgers 770C (DUKE, NCU); Caldwell, Rodgers 837C (NCU); Caswell, Rodgers 387C (NCU); Catawba, Correll 2834 (DUKE); Chatham, Rodgers 436AC (NCU); Cherokee, Oosting 34609 (DUKE, PH); Davidson, Totten, June 17, 1931 (NCU); Davie, Rodgers 759C (NCU); Durham, Coker & Totten, June 26, 1915 (NCU); Forsyth, Rodgers 378C (NCU); Franklin, Rodgers 423C (NCU); Granville, Godfrey, Aug. 11, 1938 (NCU); Guilford, Rodgers 370C (GA, NCU); Halifax, Rodgers 416C (NCU, NY); Haywood, Caughey 759 (DUKE); Iredell, Rodgers 756C (NCU); Jackson, Radford, June 25, 1946 (NCU); Johnston, Fox & Godfrey 2438 (NCS); Macon, Radford, June 22, 1946 (NCU); Madison, Rodgers 691C (NCU); McDowell, Rodgers 716C (DUKE, NCU, NY, US); Moore, Fox & Godfrey 2438 (NCS); Montgomery, Rodgers 462AC (NCU); Orange, Rodgers 486C (NCU); Person, Rodgers 395C (NCU); Polk, Peattie 1031A (NCU); Randolph, Rodgers 442C (NCU); Richmond, Rodgers 581C (NCU); Stokes, Oosting 1961 (DUKE); Swain, Oosting 35250 (DUKE); Union, Correll 944 (DUKE); Wake, Rodgers 426C (NCU); Watauga, Rodgers 816C (DUKE, GA, NCU); Yadkin, Oosting 33493 (DUKE); Yancey, Radford, July 9, 1946 (NCU). SOUTH CAROLINA: Marlboro, Radford & Stewart 412 (NCU). TENNESSEE: Anderson, Cole 758 (TENN); Blount, M. B. H. 1703 (TENN); Carroll, Svenson 364 (GH); Cheatham, Svenson 10353 (GH); Cocke, Jennison 322 (TENN); Davidson, Svenson 79 (GH); Grainger, Morrison & Brown, Aug. 12, 1936 (TENN); Hardeman, Sharp et al. 122 (TENN); Haywood, Bain 414 (GH, NY); Knox, Hesler 1652 (NY); Montgomery, Clebsch, May 26, 1946 (TENN); Sevier, Jennison 2364 (TENN); Sullivan, Sharp & J. K. U. 1516 (TENN); Unicoi, Price 753 (DUKE).

11. CORIANDRUM L. Coriander.

Glabrous, erect, branching annuals. Taproots. Leaves variable, mostly decompound. Umbels compound, opposite leaves. Bracts mostly absent; bractlets absent or simple and narrow; Flowers perfect and staminate, some distinctly irregular. Calyx-teeth distinct, often unequal. Petals white or pinkish, spreading, recurved at tips; Stylopodium conic. Ovary laterally flattened. Fruit (Fig. 11) globose, ribbed; mericarps not separating at maturity. Carpophore entire. Seed dorsally flattened, face concave.

1. *Coriandrum sativum* L. Coriander.

Plants up to 9 dm. tall, slender; lower leaves simple, trifoliate, or pinnate; upper leaves much dissected with ultimate divisions mostly linear; sheaths of petioles with hyaline margins; rays 2–8; radiant petals deeply bilobed and with obvious branching veins; fruit (Fig. 11) 1.5–5 mm. broad and tall; primary ribs wavy, secondary (6) straight, both narrow and filiform.—Introduced crop plant. Fruits used medicinally and for flavoring.

DISTRIBUTION: Waste-places throughout U. S.; seldom seen in Southeast (Map IV).

SPECIMENS CITED: NORTH CAROLINA: Iredell, Hyams, Aug., 1897 (US). TENNESSEE: Davidson, Gattinger, no number (US).

12. CONIUM L.

Glabrous (glaucous when young), tall, branching biennials; Taproots. Stem purple-spotted. Leaves decompound, the segments narrow. Umbels compound, opposite leaves, terminal on axillary branches, or cymose. Bracts and bractlets simple. Flowers irregular. Calyx-teeth obsolete. Petals white, spreading, recurved at tips. Stylopodium low-conic. Ovary and fruit laterally flattened and with wavy ribs. Carpophore split to base. Oil-tubes absent or irregular and small (not visible without magnification). Seed nearly terete, face deeply sulcate (Fig 12).

1. *Conium maculatum* L. Poison Hemlock, Snakeweed, Poison Parsley, Spotted Parsley, Winter Fern.

Plants with strong, offensive odor, up to 30 dm. tall; leaves fern-like; rays 12–18; umbelets with 17–20 flowers; stamens longer than petals, maturing before pistil; fruit broadly ovoid (Fig. 12).—Introduced. Very poisonous, especially fruits; extract from fruits used medicinally. Flowers in spring and summer.

The poisonous nature of this plant is well known to many people because a drink prepared from it was used to kill Socrates. In spite of its deadliness and foul odor, it is occasionally tolerated enough for it to become well established. A particularly impressive display of this plant can be seen between Bakersville and Red Hill in Mitchell Co. For over 3 miles along a stream it is taking over the bottomland.

DISTRIBUTION: Waste-places throughout N. A.; in Southeast (Map VIII).

SPECIMENS CITED: ALABAMA: Mobile, Mohr, June, 1896 (US). FLORIDA: Escambia, Tracy 8435 (GH, NY, US). NORTH CAROLINA: Durham, Beers, 1950 (NCU); Guilford, Rodgers 375C (GA, NCU); Mitchell, Rodgers 839C (DUKE, GA, NCS, NCU, NY, US). SOUTH CAROLINA: Charleston, Hunt 1474 (CLEMS). TENNESSEE: Unicoi, Shanks 3026 (TENN).

13. ERIGENIA Nutt.

Low, glabrous perennials. Deep globular tubers, about 1 cm. in diameter. Leaves ternately decompound. Umbels compound; rays 1–4. Bracts 1–2 and foliaceous or absent; bractlets mostly spatulate and mostly equaling or exceeding flowers and fruits. Flowers regular. Calyx-teeth obsolete. Petals white, spreading, not recurved at tips. Stylopodium absent. Ovary and fruit laterally flattened; mericarps of fruit separating in middle. Carpophore absent. Oil-tubes small, 1–3 between ribs, several on commissure. Seed laterally flattened, face deeply sulcate (Fig. 13).

1. *Erigenia bulbosa* (Michx.) Nutt. Harbinger-of-spring, Turkey pea, Pepper-and-salt.

Plants up to 20 cm. tall; leaves few, ultimate divisions mostly mucronate; sheaths of leaves with hyaline margins; rays 1–4, up to 2.5 cm. long; stamens a little longer than petals; styles about length of petals; fruit (Fig. 13) 2.5–5 mm. broad and 2–3 mm. tall; styles long, recurved in fruit; ribs primary, filiform, alike.—Native. Flowers in spring.

DISTRIBUTION: Open, rich woods. Ala., Ark., and Kans., north to N. Y. and Ont.; in Southeast, most abundant in Tenn., reported in mts. of N. C. by Kephart and Hyams.

SPECIMENS CITED: ALABAMA: Madison, Wells, 1840 (NY); Morgan, Peters, April, 1864 (NY); Tuscaloosa, Harper, 1932 (GH, NY). MISSISSIPPI: Reported by LOWE. NORTH CAROLINA: Reported in mts. by Hyams & Kephart. TENNESSEE: Bledsoe, Iltis 3194 (TENN); Davidson, Sharp & Bold 65 (TENN); Hardin, Sharp et al. 10104 (TENN); Franklin, Svenson 7560 (GH); Knox, Jennison 4002 (TENN); Lincoln, Sharp et al. 10843 (TENN); Obion, Sharp et al. 12307 (TENN); Putnam, Cain & Sharp 4381 (TENN); Shelby, Sharp et al. 10426 (TENN); Tipton, Sharp et al. 12035 (TENN); Van Buren, Shanks, March 7, 1948 (TENN).

14. FOENICULUM Adans.

Glaucous to glabrous, tall, branching biennials or perennials with strong anise odor. Taproots. Leaves dissected into filiform segments. Umbels compound, opposite bract-like leaves or cymose. Bracts and bractlets absent. Flowers regular. Calyx-teeth obsolete. Petals yellow, spreading, the tips rolled inward. Stylopodium conic, yellow. Ovary slightly laterally flattened. Fruit elongate, slightly laterally flattened, ribbed (Fig. 14). Carpophore split to base. Oil-tubes solitary between ribs, 2 on commissure. Seed dorsally flattened (Fig. 14).

1. *Foeniculum vulgare* Mill. (*F. foeniculum* Karst.) Fennel.

Plants perennial, up to 21 dm. tall; stem green; rays 7–40 (usually 10–20); stamens yellow, more than twice length of petals; styles very short; stylopodium yellow; fruit oblong-ellipsoid, almost twice as long as wide; ribs primary, alike

(Fig. 14).—Introduced crop plant. Fruits used medicinally and for flavoring. Flowers in summer and fall.

DISTRIBUTION: Open places; mts., pied., and coastal plain. Throughout U. S.; in Southeast (Map VIII).

SPECIMENS CITED: ALABAMA: Location unknown, Rhodes, Aug., 1927 (NY). FLORIDA: Duval, Lighthipe 284 (NY); Volusia, Robertson, Aug. 1, 1942 (FLA). GEORGIA: Clarke, Pyron, July 5, 1929 (DUKE); Glenn, McAtee 3278 (US). LOUISIANA & MISSISSIPPI: None. NORTH CAROLINA: Buncombe, Biltmore Herb. 442 (US); Carteret, Grady 71 (DUKE); Chatham, Rodgers 432 (NCU); Currituck, Rodgers 530C (NCU); Davidson, Rodgers 446C (GA, NCU); Forsyth, Schallert 1098 (DUKE); Guilford, Rodgers 780C (DUKE, NCU); Henderson, Rodgers 681C (DUKE, GA, NCS, NCU, US); Hyde, Rodgers 521C (NCU); Iredell, Hyams, June, 1818 (NY, US); Macon, Rodgers 632C (NCU); New Hanover, Biltmore Herb., July 16, 1897 (US); Onslow, Rodgers 861C (NCU); Orange, Rodgers 392C (NCU); Rowan, Heller, Aug. 25, 1890 (NY, PH); Transylvania, Godfrey & Fox 3019 (US). SOUTH CAROLINA: Beaufort, Cuthbert, June, 1884 (FLA); Charleston, Hunt 2211 (CLEMS); Greenwood, Cox, July 6, 1935 (FUR); York, Biltmore Herb. 442C (US). TENNESSEE: Blount, Burns, Oct. 2, 1936 (NCS); Knox, Ruth 421 (US).

15. PETROSELINUM Hoffm.

Glabrous, erect, branching annuals, biennials, or perennials. Taproots or fibrous roots. Leaves decompound; leaflets flat or crisped. Umbels compound, opposite leaves or cymose. Bracts few and simple, their margins hyaline, or bracts absent; bractlets several, their margins hyaline. Flowers nearly regular, perfect and staminate. Calyx-teeth obsolete. Petals yellow, spreading, recurved at tips. Stylopodium large, conic. Ovary laterally flattened. Fruit laterally flattened, ribbed; mericarps separating in middle. Seed nearly terete.

Leaf blades crisped ..... 1. *P. crispum*
Leaf blades flat ..... 1a. *P. crispum* var. *latifolium*

1. *Petroselinum crispum* (Mill.) Mansf. (*Apium petroselinum* L.) Parsley.

Plants up to 13 dm. tall; sheaths of leaves with hyaline margins; petals greenish-yellow or yellow; styles short; fruit (Fig. 15) oblong-ellipsoid, 2–6 mm. long; ribs primary, alike.—Introduced crop plant. Leaves used to flavor or garnish foods; fruits used medicinally and for seasoning. Flowers in late spring and summer.

DISTRIBUTION: Waste-places throughout U. S., but seldom seen in Southeast.

SPECIMENS CITED: GEORGIA: Clarke, Harper 2315 (NY, US). NORTH CAROLINA: Iredell, Hyams 4963 (NY). SOUTH CAROLINA: Darlington, Norton, April 20, 1921 (US).

1a. *Petroselinum crispum* var. *latifolium* Airy-Shaw.

This variety is cultivated to some extent in North Carolina, but most people plant the species because the crisped leaves are considered more desirable.

16. BUPLEURUM L.

Glabrous or glaucous annuals or perennials. Taproots. Leaves entire; stem leaves usually perfoliate or clasping. Umbels compound, opposite the leaves. Bracts absent or conspicuous and leafy; bractlets whorled, broad and conspicuous. Flowers regular, perfect. Calyx-teeth obsolete. Petals yellow, recurved at tips. Stylopodium conic. Ovary and fruit weakly laterally flattened, smooth to tuberculate, filiform-ribbed. Carpophore split to base. Oil-tubes various. Seed subterete.

1. *Bupleurum rotundifolium* L. Thorough-wax, Hare's Ear, Modesty.

Herbaceous annuals up to 10 dm. tall, usually branching above; leaves ovate to elliptic, entire, upper ones perfoliate, but lower ones usually clasping; rays of umbel 3–10, longest 14 mm.; bracts absent; bractlets 5–6 in whorl, ovate, elliptic, or obovate, entire, longer than flowers and fruits; stamens about length of petals; styles short; fruit (Fig. 16) ellipsoid to ovoid, 2–3.5 mm. long, dark-colored; ribs alike.—Introduced.

DISTRIBUTION: Waste-places. N. C. to Tex., north to N. Y. and S. D. (Small also gives Ariz.); in Southeast (Map II), N. C., Tenn., and reported from Ala.

SPECIMENS CITED: ALABAMA: Reported by Mohr and Harper (Green & Tuscaloosa Cos.). NORTH CAROLINA: Orange, Ashe, no number or date (US); Rowan, Heller 62 (NY, PH). TENNESSEE: Davidson, Gattinger, 1876 (GH, NY); Knox, Ruth 2857 (NCU); Rutherford, Quarterman 1616 (DUKE); Wilson, Sharp 1558 (TENN).

17. TAENIDIA Drude

Glabrous or glaucous, erect, branching perennials. Fleshy taproots. Leaves ternately or ternate-pinnately decompound; leaflets broad and entire, occasionally variously cut. Umbels compound, opposite leaves; oldest umbel tending to be predominantly staminate. Bracts and bractlets absent. Flowers regular, perfect and staminate. Calyx-teeth small or absent. Petals yellow, recurved at tips. Stylopodium absent. Ovary and fruit laterally flattened, ribbed. Carpophore split almost to base. Oil-tubes numerous between ribs and on commissure. Seed subterete.

1. *Taenidia integerrima* (L.) Drude (*Pimpinella integerrima* A. Gray) Yellow Pimpernels, Golden Alexanders.

Plants aromatic, up to 9 dm. tall; leaflets ovate, lanceolate, elliptic, or obovate, apex obtuse, obtuse-mucronate, or acute, base oblique, rounded, cuneate, or

cordate; rays 1–20, slender, spreading, unequal, up to 9.5 cm. long; mixed umbelets usually having outside flowers perfect and center ones staminate; pedicels of fruits up to 12 mm. long, slender, spreading, unequal, about twice length of pedicels of sterile flowers; stamens and styles twice length of petals; fruit (Fig. 17) ovoid or broadly ellipsoid, 3–4 mm. long; ribs primary, alike.—Native. Flowers in spring.

DISTRIBUTION: Woods, dry banks and hillsides; mostly pied. and mts. Ga. to Tex. (Cory 22866, GH), north to Que. and Ont. (Macoun, 1901; GH); in Southeast (Map X), all states except Fla. and Miss. (probably present).

SPECIMENS CITED: ALABAMA: Clarke, Porter, June 15, 1934 (GH); Madison, Mohr, May 30, 1891 (US). FLORIDA: None. GEORGIA: Catoosa, Cronquist 5400 (US); Elbert, Duncan 9431 (GA, NCU); Fulton, Harper 1275 (GH, NY, US); Lumpkin, Leeds 2066 (PH); Meriwether, Tracy 8918 (GH, NY, US); Pike, Cronquist 5485 (GH, US); Richmond, Cuthbert 660 (FLA, NY); Whitfield, Harper 298 (NY, US). LOUISIANA: Natchitoches, Palmer 7297 (NY). MISSISSIPPI: None. NORTH CAROLINA: Alamance, Totten, May 22, 1937 (NCU); Alexander, Keever 338 (DUKE); Buncombe, Biltmore Herb. 4350a (GH, NCU, NY, US); Burke, Small & Heller (NY, PH, US); Durham, Blomquist 4420 (DUKE); Jackson, Oosting 497a (DUKE); Madison, Churchill, June 7, 1899 (TENN); Mitchell, Ashe, May 25, 1893 (NCU); Orange, Rodgers 391C (GA, NCS, NCU); Polk, reported by Peattie; Wake, Ashe, May 10,—— (NCU). SOUTH CAROLINA: Pickens, Rodgers 536 (DUKE); Richland, Coker, April 5, 1935 (NCU). TENNESSEE: Anderson, Jones, April 22, 1935 (TENN); Bledsoe, Shanks et al. 4441 (TENN); Blount, Sharp 1026 (TENN); Cocke, Kearney 700 (NCU, NY, US); Franklin, Svenson 10242 (GH); Grainger, Jennison & Wilson, April 25, 1934 (TENN); Knox, Ruth 423 (NY); Marion, J. K. U. et al. 2479 (TENN); Monroe, Sharp 692 (TENN); Montgomery, Clebsch, April 24, 1946 (TENN); Sevier, Cain & Duncan 246:2 (TENN); Unicoi, Price 916 (DUKE); Union, Kalter, June 24, 1936 (TENN).

18. THASPIUM Nutt. Meadow Parsnips.

Glabrous or pubescent, erect, branching perennials. Roots fibrous, somewhat fleshy. Leaves simple to decompound. Umbels compound, opposite leaves and cymose; oldest umbel tending to be predominantly staminate. Bracts absent to few, inconspicuous; bractlets few, simple. Flowers regular, perfect and staminate. Calyx-teeth present or obsolete. Petals yellow or purple, erect, recurved at tip. Stylopodium absent; disk present. Ovary laterally flattened, ribbed. Fruit laterally flattened, some or all ribs extended as wings (Fig. 18), mericarps not separating at maturity. Carpophore obscure or distinct and split almost to base. Oil-tubes solitary between ribs, 2 on commissure. Seed slightly dorsally flattened, sulcate under oil tubes (Fig. 18).

Leaves simple or ternate (sometimes biternate or pinnate above).
Flowers purple.....1. *T. trifoliatum*
Flowers yellow.....1a. *T. trifoliatum* var. *flavum*

Leaves decompound.
Ovary and fruit glabrous between wings; blades coarsely serrate and irregularly cut
2. *T. barbinode*
Ovary and fruit puberulent between wings; blades deeply cut into narrow segments
3. *T. pinnatifidum*

1. *Thaspium trifoliatum* (L.) A. Gray Purple Meadow Parsnip.

Plants always glabrous, sparingly branched, up to 7 dm. tall; leaves simple cordate, ternate, biternate, or pinnate, often 2 or more of these types on same plant; cordate leaves occurring anywhere on plant, usually at base, sometimes absent; blades ovate or lanceolate, mostly acute, margins crenate, crenate-serrate, or serrate; terminal leaflet of trifoliate leaves (when present) tending to be truncate at base and long-petiolulate; umbels usually 1–3 to a main stem, opposite leaves; rays 5–12, longest usually under 2.5 cm.; fruits oblong-ellipsoid, about 4 mm. long, all ribs winged.—Native. Flowers in spring and summer.

DISTRIBUTION: Deciduous woods and stream banks; mts., pied., and coastal plain. Fla. to La., north to R. I. and Man.; in Southeast (Map IX), all states.

SPECIMENS CITED: ALABAMA: Dallas, Harper 3819 (GH, NY); Hale, Mohr, June, 1892 (US); Franklin, Harper 3819 (GH, NY); Lee, Earle & Baker, March 29, 1898 (PH); Talladega, Harper 78 (NY); Tuscaloosa, Harper 3723 (NY). FLORIDA: Gadsden, Curtiss, May 7, 1898 (NY). GEORGIA: Columbia, Duncan 9774 (GA); Clarke, Harper 10 (US); Early, Thorne 4973 (GA, US); Pauling, Harper 81 (NY); Pulaski, Harper 1386 (GH, NY); Richmond, Harper 1318 (GH, NY); Sumter, Harper 1050 (GH). LOUISIANA: Orleans, Drummond 128 (GH). MISSISSIPPI: Choctaw, Clute, April 28, 1899 (NY). NORTH CAROLINA: Buncombe, Biltmore Herb. 1391b (GH, NCU, NY, US); Clay, Radford, Sept. 2, 1948 (NCU); Durham, Blomquist 7554 (DUKE); Forsyth, Schallert, April 20, 1940 (GH, NY); Guilford, Wiegand & Manning 2310 (GH); Haywood, Caughey 553 (DUKE); Iredell, Veerhoff 237 (NCS); Jackson, Radford, May 29, 1947 (NCU); Johnston, Fox & Godfrey 1667 (NCS); Macon, Radford, May 31, 1947 (NCU); Pender, reported by Curtiss; Polk, Townsend, May 17, 1897 (US); Swain, Oosting 35440 (DUKE); Wake, Wiegand & Manning 2310 (GH). SOUTH CAROLINA: Abbeville, Hexamer & Maier, no number or date (GH); Aiken, Ravenel, no number or date (NY); Anderson, Gibbs, 1886 (NY); Oconee, Rice, April 29, 1930 (CLEMS); Pickens, House 2160 (PH, US). TENNESSEE: Bledsoe, Harger 7714 (TENN); Bradley, Hester & Sharp 992 (TENN); Claiborne, Talcott 1889 (US); Cocke, Kearney 704 (NY, US); Davidson, Svenson & Shaver 9622 (GH, TENN); Jackson, Bain 411 (NY); Knox, Ruth, June, 1897 (NY); Maury, Weatherby 6343 (GH, TENN); Roane, Pollard & Maxon 415 (US); Union, Morrison, June 14, 1937 (TENN).

1a. *Thaspium trifoliatum* var. *flavum* Blake (*T. trifoliatum* var. *aureum* Brit.) Yellow Meadow Parsnip.

This plant differs from the species in having yellow flowers. It is often confused with *Zizia aptera*.

DISTRIBUTION: Deciduous woods and stream banks; mts., pied., and coastal plain. Fla. to La., and Okla., north to Penn. and Ont.; in Southeast (Map IX), all states.

SPECIMENS CITED: ALABAMA: Franklin, Harper 3819 (US); Lee, Earle, May 18, 1901 (NY); Talladega, Harper 78 (US). FLORIDA: Liberty, Beck, March 17, 1949 (FLA). GEORGIA: Clarke, Harper 145 (US); Columbia, Duncan 774 (GA, NCU); Pulaski, Harper 1386 (US); Rabun, Radford, May 31, 1947 (NCU); Richmond, Harper 1318 (US); Sumter, Harper 1050 (NY, US). LOUISIANA: St. Tammany, Arsene 12391 (US). MISSISSIPPI: Grenada, Millsaps, May 15, 1932 (NCU); Oktibbeha, Phares 7 (US). NORTH CAROLINA: Alamance, Rodgers 364C (NCU); Avery, Kelsey, Sept., 1890 (US); Buncombe, Rodgers 706C (NCS, NCU, NY, US); Chatham, Rodgers 223C (DUKE, NCU); Harnett, Rodgers 114C (NCU); Haywood, reported by Radford; Johnston, Mitchell, May 20, 1936 (DUKE); Macon, Radford, May 31, 1947 (NCU); Mitchell, Ashe, May 8, 1893 (NCU); Moore, Fox & Godfrey 1370 (NCS); New Hanover, reported by Wood & McCarthy; Orange, Rodgers 108C (NCU); Polk, reported by Peattie; Swain, Beardslee & Kofoid 4000 (TENN). SOUTH CAROLINA: Aiken, Ravenel, Sept., 1869 (US); Greenville, collector unknown, June 30 1937 (FUR). TENNESSEE: Bledsoe, Harger 7775 (GH); Blount, Jennison 41 (TENN); Hardeman, Sharp et al. 12689 (TENN); Knox, Ruth 425 (GH, NY); Lewis, Sharp et al. 10085 (TENN); Montgomery, Clebsch, March 30, 1946 (TENN); Sevier, Cain & Duncan 391:2 (TENN); Shelby, Sharp et al. 10486 (TENN); Sumner, Gattinger, 1883 (GH); Tipton, Sharp et al. 12148 (TENN).

2. *Thaspium barbinode* (Michx.) Nutt. Hairy Golden Alexander, Hairy-jointed Parsnip, Hairy-jointed Meadow Parsnip.

Plants loosely branching, usually pubescent at nodes, up to 12 dm. tall; leaves biternate, triternate, or ternate-pinnate (to simple ternate above); leaflets ovate or elliptic, acute at apex; umbels mostly cymose, occasionally opposite leaves; rays 5–15, mostly 2 cm. or shorter; umbelets with perfect flowers on outside and staminate ones in center; calyx-teeth triangular; styles longer than petals; fruit (Fig. 18) subellipsoid, about 6 mm. long; seven ribs usually extended as wings (4 laterals, 1 dorsal, and 2 intermediates); carpophore split almost to base.—Native. Flowers in spring and summer.

DISTRIBUTION: Rich woods and stream banks; mts., pied., and coastal plain. Fla., Ala., and Okla., north to N. Y. and Ont.; in Southeast (Map IX), all states except La. and Miss. (reported).

SPECIMENS CITED: ALABAMA: Clarke, Harper 3375 (GH, NY, PH, US); Jackson, Porter, June 11, 1934 (GH); Lee, Earle & Baker, May 29, 1897 (NY); Madison, Pollard & Maxon 365 (NY); Walker, Harper 329 (US). FLORIDA: Duval, Curtiss 1023 (NY); Walton, Curtiss, summer 1885 (NY). GEORGIA: Burke, Leeds & Harper 2762 (PH); Cobb, Perry & Myers 958 (GH, NY); Columbia,

Smith, July 7, 1890 (NY, US); Lincoln, Duncan 10018 (GA, NCU); Lumpkin, Pyron & McVaugh 2897 (US); Pickens, Leeds 2126 (DUKE); Randolph, Harper 2230 (GH, NY, US); Walker, Harper 329 (NY). LOUISIANA: None. MISSISSIPPI: Reported by Lowe. NORTH CAROLINA: Ashe, Fox 2472 (NCS); Buncombe, Caughey 219 (DUKE); Caldwell, Radford & Stewart 1580 (NCU); Catawba, Churchill, June 13, 1899 (GH); Chatham, Rodgers 78C (NCU); Davidson, Totten, June 17, 1931 (NCU); Durham, Sample 7 (DUKE); Forsyth, Rodgers 783C (NCU); Gaston, Rodgers 742C (NCU); Granville, Rodgers 402C (NCU); Haywood, Caughey 548 (DUKE); Henderson, Fox et al. 2210 (NCS); Iredell, Veerhoff, May 26, 1935 (NCS); Jackson, Radford, June 26, 1946 (NCU); Madison, Beaver 265 (DUKE); McDowell, Peattie 941 (NCU); Mecklenburg, Curtis, no number or date (NY); Mitchell, Merriam, Aug. 8, 1892 (US); New Hanover, reported by Wood & McCarthy; Orange, Rodgers 100C (NCU); Polk, Townsend, June 17, 1897 (US); Rockingham, Rodgers 384C (NCU); Surry, Rodgers 789C (NCU); Swain, Fox et al. 2181 (GA); Vance, Rodgers 408C (NCU); Wake, Godfrey 3403 (GH, NCS); Watauga, Radford 259C (NCU). SOUTH CAROLINA: Beaufort, Mellichamp, 1878 (GH, NY); Berkeley, Moldenke 1226a (DUKE, NY); Darlington, Smith, May 15, 1941 (NCU); Dorchester, Hunt 1661 (CLEMS); Georgetown, Godfrey & Tryon 1483 (US); Greenville, Thomason, April 30, 1935 (FUR); Oconee, House 2973 (US); Orangeburg, Godfrey & Tryon 1493 (DUKE, GH, NY, TENN); Pickens, House 2411 (US); Richland, Philson, April 23, 1936 (DUKE). TENNESSEE: Bledsoe, Shanks et al. 4429 (TENN); Blount, Godfrey, April 21, 1934 (TENN); Carter, Brown 28 (DUKE); Chatham, Svenson 10293 (DUKE); Cocke, Kearney 703 (US); Dickson, Svenson 4392 (GH); Franklin, Svenson 10179 (DUKE); Grainger, Morrison, July 23, 1936 (TENN); Knox, Ruth 213 (GH, NY); Polk, Sharp et al. 10528 (TENN); Sevier, Anderson 839 (GH); Sullivan, Vail, May 24, 1892 (NY); Unicoi, Price 711 (DUKE); Union, Kelly 2448 (TENN); Van Buren, Sharp et al. 11455 (TENN); Warren, Sharp et al. 11266 (TENN); Wayne, Sharp et al. 10187 (TENN).

3. *Thaspium pinnatifidum* (Buckl.) A. Gray Cut-leaved Meadow Parsnip.

Plants pubescent (especially at nodes), branching, up to 6 dm. tall; umbels cymose and opposite leaves; styles about length of petals; fruit subellipsoid, 3–4 mm. long, ribs all winged, shallow.—Native. Flowers in spring and summer.

DISTRIBUTION: Rich woods and along streams in mts. Ala. (reported), Tenn., Ky., and N. C. (Map IX).

SPECIMENS CITED: ALABAMA: De Kalb (LOOKOUT MT.), reported by Mohr. NORTH CAROLINA: Macon, Rugel, Sept., 1842 (GH); Madison, Churchill, June 3, 1899 (GH, TENN); Swain, Beardslee & Kofoid, Aug. 1, 1891 (GH, NY, US). TENNESSEE: Cocke, Sharp 1417 (TENN).

19. ZIZIA Koch Meadow Parsnips.

Glabrous or pubescent, erect perennials. Roots fibrous, somewhat fleshy. Leaves simple to decompound; blades broad. Umbels compound, opposite leaves

or rarely cymose; oldest umbel predominantly staminate. Bracts absent or few and simple; bractlets simple. Flowers regular, perfect (sessile if in center of umbelet) and staminate. Calyx-teeth absent or distinct. Petals yellow, erect, recurved at tips. Stylopodium absent; disk present. Ovary and fruit laterally flattened, ribbed. Ribs filiform, alike. Carpophore split ½ or all way to base. Oil-tubes solitary between ribs, 2 on commissure. Seed subterete, sulcate under oil-tubes.

Basal leaves simple cordate or trifoliate.....1. *Z. aptera*
Basal leaves with more than 3 blades or if 3 blades, the terminal leaflet deeply cut into 3 parts and leaves appearing 5-foliate.
  Basal leaves usually with 5 or more leaflets; leaf blades uniformly fine-serrate; rays short, longest usually about 2.5–3.5 cm. long, rarely up to 5.5 cm., in fruit and 1–1.5 cm. long in flower.....2. *Z. aurea*
  Basal leaves mostly 3-foliate or appearing 5-foliate if terminal leaflet deeply cut into three parts, rarely 5-foliate or more; leaf blades usually crenate-serrate; rays long, longest usually 4–5 cm. long, rarely up to 8 cm., in fruit and usually 2–4.5 cm. long in flower.....3. *Z. trifoliata*

1. *Zizia aptera* (A. Gray) Fern. (*Z. cordata* [Walt.] D. C.) Heart-leaved Alexander, Golden Parsnip.

Plants pubescent or glabrous, sparingly branched, up to 6 dm. tall; stem leaves mostly trifoliate; leaflets ovate, lanceolate, and oblanceolate, margins crenate, crenate-serrate, dentate, or serrate, sometimes cut; terminal leaflet usually tapering to base; umbels mostly 1–5; rays 3–16, up to 3.5 cm. long; fruit (Fig. 19) broadly ellipsoid, about 3 mm. long.—Native. Flowers in spring and summer.

This plant is commonly confused with *Thaspium trifoliatum* var. *flavum*.

DISTRIBUTION: Rich woods; chiefly pied. and mts. Ga., Ala., Colo., Utah, and Ore., north to Can.; in Southeast (Map X), Ala., Ga., S. C., N. C., and Tenn.

SPECIMENS CITED: ALABAMA: Henry, Wiegand & Manning 2311 (GH); Jackson, Harper 3923 (GH, US); Lee, Earle & Baker, May 7, 1898 (US). FLORIDA: None. GEORGIA: Clarke, Pyron, April 16, 1930 (DUKE); Catoosa, Churchill, May 25, 1911 (GH); Haralson, Way 28 (US); Lumpkin, Leeds 2067 (PH); Madison, Harper 1501 (PH); Rabun, Cronquist 5538 (GH, US); Richmond, Cuthbert, April 16, 1902 (FLA). LOUISIANA & MISSISSIPPI: None. NORTH CAROLINA: Buncombe, Ashe, Aug. 31, 1892 (NCU); Burke, Rodgers 728C (NCU); Caldwell, Blomquist 13861 (DUKE); Chatham, Rodgers 227C (NCU); Clay, Rodgers 614 (NCU, US); Durham, Oosting 2245 (DUKE); Forsyth, Schallert 14664 (NCU); Halifax, Bartram, April 19, 1908 (GH); Henderson, Garren 218 (DUKE); Jackson, Radford, May 29, 1947 (NCU); Macon, Radford, May 31, 1947 (NCU); Mecklenburg, Brimley, April 13, 1922 (NCS); Mitchell, Ashe, June, 1893 (NCU); Moore, Godfrey et al. 49141 (NCS); Orange, Rodgers 101C (NCU); Polk, Peattie 2202 (NCU); Richmond, Williamson, April 15, 1895 (PH); Rowan, Heller 63 (NY, PH);

Swain, Beardslee & Kofoid, Aug. 20, 1891 (PH); Warren, Godfrey 3636 (GH); Wake, Godfrey 3687 (NCU). SOUTH CAROLINA: Darlington, Norton, April 26, 1921 (NCU); Greenville, Fallaw, no number or date (FUR); Richland, Philson, April 23, 1936 (DUKE). TENNESSEE: Anderson, Varnell, April 24, 1937 (TENN); Bledsoe, Harger 7775 (TENN); Campbell, Hesler et al. 2246 (TENN); Carter, Rydberg 8185 (NY); Fentress, Shanks 1525 (TENN); Hamilton, Pollard & Maxon 421 (US); Knox, Ruth, June, 1893 (PH); Marion, Sharp et al. 10671 (TENN); Sevier, Anderson & Jennison 872 (GH); Van Buren, Shanks 3373 (TENN).

2. *Zizia aurea* (L.) Koch Golden Meadow Parsnip, Golden Alexander, Early Meadow Parsnip, Wild Parsley.

Plants glabrous, up to 8 dm. tall; leaflets ovate, lanceolate, or elliptic, acute at apex, cordate, truncate, cuneate, or oblique at base; umbels mostly 3–10; rays 4–15; fruit oblong-ellipsoid to oblong-ovoid, about 4 mm. long.—Native. Flowers in spring and summer

DISTRIBUTION: Low woods and meadows, often by streams; mts. and pied., sometimes coastal plain. Fla. to Tex., north to Que. and Sask.; in Southeast (Map X), all states.

SPECIMENS CITED: ALABAMA: Chilton, Harper 3175 (NY); Clay, Earle, Aug. 28, 1897 (NY); Cullman, Harbison 4212 (NCU); Tuscaloosa, Harper 3723 (US). FLORIDA: Alachua, Murrill, April 13, 1940 (DUKE); Gadsden, Curtiss, May 7, 1898 (NY). GEORGIA: Bibb, Small, May 18–24, 1895 (NY); Clarke, Pyron, May 7, 1930 (DUKE); Floyd, Biltmore Herb. 4811a (US); Lincoln, Duncan 10327 (GA, NCU); Meriwether, Tracy 8917 (NY); Quitman, Harper 1901 (NY); Randolph, Thorne & Muenscher 7923 (GH); Richmond, Cuthbert 248 (NY); Sumter, Harper, June, 1897 (NY); Union, Leeds 2068 (PH); Whitfield, Harper 244 (NY, US). LOUISIANA: Rapides, Hale, no number or date (NY). MISSISSIPPI: Lowndes, Harbison 4192 (NCU). NORTH CAROLINA: Alamance, Rodgers 365C (NCU); Cabarrus, Rodgers 771C (NCU); Caldwell, Blomquist 13875 (DUKE); Durham, Godfrey 3826 (NCU); Forsyth, Schallert, June 19, 1947 (FLA); Graham, Rodgers 624C (NCU, US); Granville, Rodgers 403C (NCU); Haywood, Blomquist 4425 (DUKE); Henderson, Rodgers 646C (NCU); Mitchell, reported by Gray; Montgomery, Rodgers 462C (NCU); Moore, Fox & Godfrey 1370 (FLA, NCS); Orange, Ashe, May, 1898 (NCU); Polk, reported by Peattie; Randolph, Rodgers 437C (NCU); Rowan, Rodgers 764C (NCS, NCU); Stanly, Rodgers 462C (NCU); Swain, Radford 5260 (NCU); Union, Rodgers 774C (DUKE, NCU). SOUTH CAROLINA: Berkeley, Ravenel, no number or date (GH); Charleston, Godfrey & Tryon 680 (GH, NY, PH, TENN). TENNESSEE: Davidson, Svenson 9592 (GH); Dickson, Svenson 10322 (DUKE, TENN); Lewis, King 69 (DUKE); Wilson, Svenson 9592 (GH).

3. *Zizia trifoliata* (Michx.) Fern. (*Z. bebbii* Brit.) Bebb's Zizia.

Plants glabrous, slender, up to 6 dm. tall; leaflets ovate, lanceolate, or elliptic, acute or obtuse at apex, cuneate, truncate, or oblique at base; umbels 1–5;

rays 2–14, slender, often lax; fruit ovoid or broadly ellipsoid, 2–4.5 mm. long. —Native. Flowers in spring and summer.

DISTRIBUTION: Deciduous woods; mts. and pied., sometimes coastal plain. Fla. to Va., Tenn., W. Va., and Ark.; in Southeast (Map X), all states except Ala., Miss., and La.

SPECIMENS CITED: FLORIDA: Alachua, West & Laessle, May 10, 1934 (FLA); Jackson, Explor. Party, March 15, 1937 (FLA); Marion, Miller 536 (US). GEORGIA: Colquitt, Harper 1940 (GH); Meriwether, Tracy 8917 (GH, US); Quitman, Harper 1901 (GH, NY); Rabun, Radford, May 30, 1947 (NCU); Richmond, Cuthbert, May 3, 1901 (FLA); Sumter, Harper 1020 (GH). NORTH CAROLINA: Ashe, Rodgers 808C (NCU, US); Avery, Radford, July 11, 1946 (NCU); Buncombe, Browne, July 2, 1949 (NCU); Burke, Freeman, June 7, 1926 (DUKE); Caldwell, Blomquist 13872 (DUKE); Chatham, Rodgers 81C (NCU); Forsyth, Schallert, May, 1940 (NY); Haywood, Coker et al., July 28, 1926 (NCU); Henderson, reported by Memminger; Iredell, Veerhoff 209 (NCS); Jackson, Rodgers 596C (DUKE, NCS, NCU); Macon, Rodgers 597C (NCU); Madison, Churchill, June 9, 1899 (GH); McDowell, Fox et al. 2170a (NCS); Mitchell, Ashe, June, 1893 (NCU); Orange, Radford 805a (NCU); Polk, Peattie 701 (NCU); Rockingham, DeChalmot, no number or date (US); Rowan, Heller 68 (PH); Rutherford, Rodgers 731C (NCU); Surry, Rodgers 791C (NCU, NY); Swain, reported by Cain; Transylvania, Rodgers 598C (GA, NCS, NCU); Wake, Godfrey, April 27, 1937 (NCS); Watauga, Rodgers 818C (GA, NCU); Yancey, Rodgers 721C (NCU). SOUTH CAROLINA: Greenville, Gibbs, —— (NY); Oconee, House 1973 (US); Pickens, Rodgers 514a (DUKE); Williamsburg, Wiegand & Manning 2308 (GH). TENNESSEE: Carter, Brown 18 (DUKE); Cocke, Kearney 701 (NCU, NY, US); Sevier, Cain & Duncan 427:2 (TENN); Sullivan, Jennison et al. 815 (TENN); Unicoi, Price 989 (DUKE).

20. CARUM L. Caraways.

Glabrous, branching biennials. Taproots fleshy. Leaves pinnately decompound, the segments linear to filiform; sheaths of petioles with hyaline margins. Umbels compound, opposite leaves. Bracts and bractlets absent to few. Flowers white or faintly rose. Calyx-teeth obsolete. Petals spreading, recurved at tips. Stylopodium conic. Ovary and fruit laterally flattened, ribbed. Carpophore split to base. Oil-tubes large, solitary between ribs, 2 on commissure. Seed nearly terete.

1. *Carum carvi* L. Caraway, Carvies.

Plants up to 10 dm. tall; umbels exceeding in length the leaves they oppose; rays and pedicels unequal in flower and fruit, rays 5–14; bracts absent or 1–2, simple or dissected; bractlets absent or few and simple; stamens twice length of petals; styles shorter than petals; fruit (Fig. 20) ellipsoid, oblong-ovoid, or oblong-ellipsoid, 3–4 mm. long; ribs primary, alike; seed sulcate under oil-tubes.—Introduced. Fruits used medicinally and for flavoring.

Caraway is occasionally grown in gardens and might be expected to escape from cultivation.

DISTRIBUTION: Waste-places. N. C. to E. Can., west to Wash. and B. C.; in Southeast, only collection seen from Junaluska Mt., N. C.

SPECIMEN CITED: NORTH CAROLINA: Haywood, Blomquist 4370 (DUKE).

21. LIGUSTICUM L.

Mostly glabrous, erect perennials. Roots large, bearing a crown of fibers. Leaves decompound, petiolate. Umbels compound. Bracts absent or inconspicuous; bractlets absent or few and narrow. Flowers regular. Calyx-teeth obsolete to distinct. Petals white or pinkish, recurved at tips. Styles short. Ovary and fruit longer than wide, laterally flattened; fruit ribbed. Carpophore split to base. Oil-tubes numerous between ribs and on commissure. Seeds dorsally flattened.

1. *Ligusticum canadense* (L.) Brit. Lovage, Angelico, Sea Parsley.

Plants tall, up to 20 dm., glabrous, coarse; roots with odor of celery; stems very brittle; leaves 1–4-ternate or ternate-pinnate, very large at base, reduced to simple bract-like structures on inflorescence branches; blades ovate, elliptic, or lanceolate, coarsely serrate, acute at apex, cuneate or oblique at base; umbels cymosely displayed on naked-appearing branches, these branches opposite or whorled; rays 4–14; petals white; stamens more than twice length of petals; fruits (Fig. 21) ellipsoid to ovoid, about 5 mm. long; ribs primary, thin, alike.—Native. Flowers in spring and summer.

DISTRIBUTION: Rich woods and embankments; mts. and pied., rarely coastal plain. Ga. to Ark., north to Penn. and Mo.; in Southeast (Map II), Ala., Ga., S. C., N. C., and Tenn.

SPECIMENS CITED: ALABAMA: Cullman, Mohr, June 23, 1895 (US); De Kalb, Harper 3999 (US); Etowah, Pollard & Maxon 348 (US); Lee, Earle & Baker 1162 (NY). FLORIDA: None. GEORGIA: Clarke, Harper 41 (GH, NY); Dade, Eyles 5 (GH); De Kalb, Small, Aug. 1–6, 1895 (NY); Gwennett, Small, July 11, 1893 (NY, US); Jasper, Porter, 1846 (PH); Madison, Harper 1528 (PH); Pickens, Leeds 2125 (DUKE, PH); Rabun, Radford, Aug. 24, 1946 (NCU); Richmond, Cuthbert, July, 1900 (FLA); Stephens, Duncan 10030 (GA, NCU); Sumter, Harper 1019 (GH, NY, US); Walker, Ruth 425 (US). LOUISIANA & MISSISSIPPI: None. NORTH CAROLINA: Alleghany, Rodgers 801C (NCS, NCU); Ashe, Rodgers 807C (NCU); Avery, Rodgers 823C (NCU); Buncombe, Rodgers 709C (NCU); Burke, Rodgers 722C (NCU); Caldwell, Small & Heller, July 31, 1891 (NY); Chatham, Rodgers 434C (NCU); Cherokee, Rodgers 618C (NCU); Durham, Blomquist 943 (DUKE); Forsyth, Rodgers 784C (NCU); Gaston, Rodgers 744C (NCU); Graham, Rodgers 625C (NCU); Haywood, Rodgers 699C (NCU); Henderson, reported by Memminger; Iredell, Hyams, July, 1880 (NY); Jackson, Rodgers 595C (NCU); Johnston, Fox & Godfrey 1681 (DUKE, FLA, NCS); Macon, Rodgers 590C (NCU); Madison, Rodgers 689C (NCU); McDowell, Rodgers 718C (NCU); Mitchell, Chickering, July 1, 1880 (US); Montgomery, Rodgers 582C (NCU); Orange,

Rodgers 207C (NCU); Polk, Peattie 1356A (NCU); Rowan, Heller 66 (PH); Rutherford, Rodgers 730C (NCU); Stanly, Rodgers 453C (NCU); Stokes, Sample 17 (DUKE); Surry, Williams 255 (DUKE); Swain, Beardslee 12 (US); Transylvania, Rodgers 601C (NCU); Wake, Rodgers 429C (NCU); Warren, Rodgers 410C (NCU); Watauga, Rodgers 817C (NCU); Yancey, Rodgers 824C (NCU). SOUTH CAROLINA: Anderson, F. H. E., 1886 (NY); Greenville, Peattie 1263A (NCU); Lancaster, Huntley 286 (DUKE); Pickens, Rodgers 347 (DUKE). TENNESSEE: Carroll, Sharp et al. 13094 (TENN); Carter, Britton, Sept. 11, 1895 (NY); Cocke, Kearney 704 (NCU, NY); Hamilton, Bicknell, June, 1894 (NY); Knox, student 2718 (TENN); Morgan, Rice & Underwood 1336 (TENN); Rhea, Shanks et al. 4373 (TENN); Sevier, Sharp & M. B. W. 1253 (TENN); Van Buren, Shanks & Clebsch 4530 (TENN).

22. AEGOPODIUM L. Goutweeds.

Coarse, glabrous, branching perennials. Fibrous roots from rhizomes. Leaves biternate or ternate, blades broad, toothed or sometimes cut. Sheaths of petioles with hyaline margins. Umbels compound, opposite the leaves or cymose. Bracts and bractlets usually absent. Flowers regular. Calyx-teeth small or absent. Petals white, spreading, recurved at tips. Stylopodium conic. Ovary laterally flattened, longer than wide. Fruit laterally flattened, longer than wide, ribbed. Oil-tubes absent. Seed subterete.

1. *Aegopodium podagraria* var. *variegatum* Bailey. Goutweed, Goutwort, Herb-Gerard, Wild or English Masterwort, Bishop's-weed, Dwarf Elder, Bishop's-Elder, White-ash-herb.

Plants up to 11 dm. tall; leaves variegated, biternate below to ternate above; blades ovate, elliptic, or lanceolate, acute to acuminate, serrate and sometimes cut; rays of umbel 9–25; stamens more than twice length of petals; styles shorter than petals; fruit ovoid to oblong-ovoid, 3–4 mm. long; ribs filiform, equal.—Introduced ornamental. Flowers in summer.

DISTRIBUTION: Waste-places, especially around homesites in E. Amer. from N. C. to Que.

SPECIMEN CITED: NORTH CAROLINA: Forsyth, Siewers, May 12, 1911 (DUKE).

23. SPERMOLEPIS Raf.

Glabrous, slender, branching annuals. Taproots. Leaves finely dissected. Umbels compound with few rays and flowers. Bracts absent or solitary and simple; bractlets few and narrow. Flowers regular. Calyx-teeth obsolete. Petals white, not recurved at tips. Stamens and styles shorter than petals. Ovary and fruit laterally flattened, usually with tubercles or bristles. Carpophore split at tip. Oil-tubes usually solitary between ribs, 2 on commissure. Seed nearly terete, face sulcate.

1. *Spermolepis divaricata* (Walt.) Brit. Rough-fruited Spermolepis.

Plant up to 7 dm. tall, delicate, much-branched; sheaths of leaves with hyaline margins; umbels asymmetrical, borne on rather symmetrically forked branches; rays 3–7, slender, equal or unequal, the center one sometimes very short and bearing a reduced umbelet; pedicels 1–6, unequal, very slender; flowers small, center ones often sessile or on short pedicels; ovary tuberculate; fruit (Fig. 22) tuberculate, ellipsoid, ovoid, or orbicular, 1.5–2 mm. long; ribs primary, alike. —Native. Flowers in spring. This plant is sometimes confused with *Apium leptophyllum*.

DISTRIBUTION: Open waste-places, especially sandy soil; coastal plain. Fla. to Tex., north to Va. (N. J. on ballast) and Kans. (Small gives N. M.); in Southeast (Map VIII), all states (reported in Tenn.).

SPECIMENS CITED: ALABAMA: Baldwin, Schallert 526 (DUKE); Clay, Harper 3733 (GH, NY, PH, US); Crenshaw, Earle 2035 (US); Mobile, Mohr, May, 1877 (GH, NY, US). FLORIDA: Alachua, Meredith, March 14, 1899 (PH); Baker, West & Arnold, April 25, 1940 (FLA); Bay, Banker 3676 (NY); Bradford, West & Arnold, May 15, 1940 (FLA); Brevard, Rhoads, March 23, 1928 (FLA); Columbia, Jaspersen, March 29, 1893 (FLA); Dade, Biltmore Herb. 1351c (NY, US); Duval, Curtiss 4609 (GH); Escambia, Baker 1624 (NY, US); Gadsden, Rugel, May, 1843 (NY); Gilchrist, Martin et al., May 19, 1940 (FLA); Hamilton, West & Arnold, April 11, 1940 (FLA); Hillsborough, Smith, March 10, 1880 (GH, US); Lake, Nash, April 1–15, 1894 (GH, NY, PH); Leon, Kurz, May, 1943 (FLA); Levy, Garber, April, 1876 (PH, US); Marion, Rhoads, April 16, 1937 (FLA); Osceola, Singeltary 220 (DUKE, NCS); Pasco, Barnhart 2555 (NY); Pinellas, Moldenke 1057 (DUKE, NY); Polk, Schallert 1332 (FLA); Putnam, Barnhart 2056 (NY, US); Seminole, Torrey, March, 1872 (NY); St. Johns, Curtiss 6133 (FLA, NCU); Sumter, West & Arnold, April 4, 1946 (FLA); Suwanee, Explor. Party, March 17, 1939 (FLA); Volusia, Oosting 209 (DUKE). GEORGIA: Burke, Harper 773 (NY, US); Chatham, Small 8490 (GH, NY, US); Houston, Ainsworth, May 7, 1944 (PH); Jenkins, Harper 787 (GH, NY, US); Richmond, Porter, April, 1847 (PH); Screven, Cronquist 4995 (GH, US). LOUISIANA: County unknown, Torrey, 1839 (GH). MISSISSIPPI: Harrison, Tracy, May 3, 1898 (GH); Jackson, Skehan S126 (DUKE). NORTH CAROLINA: Bladen, Rodgers 266C (NCU); Brunswick, Rodgers 313C (NCU); Carteret, Ashe, April 11, 1898 (NCU); Columbus, Rodgers 273C (GA, NCU, NY); Craven, reported by Croom; Cumberland, collector and date unknown (GH, NY); Dare, Ashe, April 11–25, 1898 (NCU); Harnett, Rodgers 261C (DUKE, NCU); Johnston, Rodgers 184C (NCU); Moore, Radford & Stewart 318 (NCU); New Hanover, Rodgers 302C (NCU); Richmond, Williamson, 1895 (PH); Robeson, Rodgers 337C (NCU, US); Samson, Correll 386 (DUKE); Wake, Buell 1967 (DUKE, NCS); Wayne, Totten, May 14, 1926 (NCU). SOUTH CAROLINA: Aiken, Biltmore Herb. 1351b (US); Beaufort, Churchill, May 2, 1917 (GH); Charleston, Robinson 162 (GH); Chesterfield, Williamson, April, 1895 (PH); Clarendon, Stone 94 (PH); Darlington, Smith, May 12, 1932 (NCU); Dorchester, Hunt 821A (CLEMS);

Florence, Bartram 2267 (PH); Georgetown, Radford & Stewart 986 (NCU); Horry, Powell, June 23, 1931 (FUR); Orangeburg, House 3288 (NY); Richland, Bartram, May 16, 1912 (PH). TENNESSEE: Davidson, reported by Gattinger.

24. APIUM L.

Glabrous, branching annuals, biennials, or perennials. Taproots or rhizome with fibrous roots. Leaves pinnately or ternately compound to decompound. Umbels compound or simple, sessile or pedunculate, opposite leaves. Bracts and bractlets present or absent. Flowers nearly regular. Calyx-teeth small or obsolete. Petals white, spreading, recurved or straight at tips; stylopodium conic. Ovary and fruit laterally flattened, ribbed. Carpophore entire or split nearly to base. Oil-tubes solitary between ribs, 2 on commissure. Seed subterete.

Delicate, weak-stemmed annuals with filiform or linear leaflets; umbels simple or compound (1–3 rays); petals not recurved at tips ..... 1. *A. leptophyllum*
Robust, strong-stemmed biennials with broad leaflets; umbels compound (6–16 rays); petals recurved at tips ..... 2. *A. graveolens*

1. *Apium leptophyllum* (Pers.) F. Muell. (*Cyclospermum ammi* [L.] Brit.) Marsh Parsley.

Plants with green, slender stems, erect or creeping, up to 7 dm. long; blades of leaves with only one vein; umbels numerous along most of stem length, simple umbels usually 1–3 from a node, compound umbels, if present, sessile or pedunculate; flowers small, 1–18 to umbelet, central flower sometimes sessile or subsessile; calyx-teeth absent; stamens and styles shorter than petals; stylopodium low; ribs primary, equal; carpophore split at apex; seed subterete.—Native. Flowers in spring and summer. This plant is sometimes confused with *Spermolepis divaricata*.

DISTRIBUTION: Waste-places, often in very sandy soil; coastal plain. Fla. to N. C., west to Tex., Ariz., N. M., and Calif. (on ballast grounds on Long Island, N. Y., and in Ore.); Mex., C. A., W. I., and S. A.; in Southeast (Map VIII), all states (reported to be common on coast of Miss.).

SPECIMENS CITED: ALABAMA: Mobile, Mohr, 1897 (US); Sumter, Harper 3594 (GH, NY, PH, US). FLORIDA: Alachua, Murrill, May 6, 1940 (DUKE); Baker, West & Arnold, April 25, 1940 (FLA); Columbia, Morris, June 18, 1903 (US); Dade, Small 6816 (DUKE, FLA, GH, NCU, NY, TENN); Duval, Curtiss, March 28, 1894 (NCS, NY, PH, US); Franklin, Chapman, 1875 (US); Gadsden, Curtiss 6165 (FLA); Jefferson, Lighthipe, March, 1890 (NY); Leon, Moldenke 5982 (NY); Putnam, Barnhart 2122 (NY); Volusia, Small 8678 (FLA, GH, NY, US); Walton, Hume, May 9, 1938 (FLA). GEORGIA: Chatham, Kolthoff, April 9, 1927 (US); Clarke, Dunnaway, May 23, 1929 (TENN); Glynn, McAtee 3265 (US). LOUISIANA: Jefferson, Ball 310 (GH, US); Natchitoches, Palmer 7382 (NY); Orleans, Pond, Feb. 21, 1888 (US); Plaquemines, Tracy & Lloyd 136 (GH, US); Rapides, Ball 384 (GH, US); Terrebonne, Innes & Warnock 713 (GH). MISSISSIPPI: Along coast,

reported by Lowe. NORTH CAROLINA: Brunswick, Rodgers 321C (NC, NY); Johnston, Rodgers 341C (DUKE, NCU); Richmond, Williamson, May, 1895 (PH); Robeson, Rodgers 338C (GA, NCU). SOUTH CAROLINA: Beaufort, Churchill, May 1, 1917 (GH); Charleston, Robinson 164 (GH); Dorchester, Correll 5334 (NCS); Georgetown, Godfrey & Tryon 282 (DUKE, GH, TENN); McCormick, Duncan 9467 (GH); Richland, Taylor, no number or date (GH, NY, US). TENNESSEE: Wilson, Svenson 7158 (GH, TENN).

2. *Apium graveolens* L. (*Celeri graveolens* Brit.) Celery, Smallage.

Plants aromatic, up to 15 dm. tall; stems ridged and grooved; basal leaves pinnate-ternate or bipinnate, blades cuneate at base, toothed and variously cut; cauline leaves trifoliate or 3-lobed; umbels numerous, sessile or short-peduncu-late; calyx-teeth obscure or small; stamens slightly longer than petals, styles short; fruits (Fig. 23) subellipsoid, about 1.5 mm. long; ribs primary, filiform; carpophore split at apex; seed nearly terete (Fig. 23).—Introduced as food plant. Fruits used medicinally and for flavoring. Flowers in spring and summer.

DISTRIBUTION: Waste-places throughout U. S.; in Southeast (Map VIII), rare.

SPECIMENS CITED: NORTH CAROLINA: Brunswick, Rodgers 322C (NCU). SOUTH CAROLINA: Charleston, Hunt 1547 (CLEMS); Darlington, Norton, April 20, 1921 (US). TENNESSEE: Reported by Gattinger.

25. AMMI L. Bishop's-weeds.

Glabrous, branching annuals, biennials, or perennials. Taproots. Leaves de-compound, the ultimate divisions filiform, linear, or lanceolate. Umbels com-pound. Bracts and bractlets numerous. Calyx-teeth obsolete. Petals white, recurved at tips. Stylopodium low-conic. Ovary laterally flattened. Fruit laterally flattened, ribbed. Carpophore entire or split to base. Oil-tubes solitary between ribs, 2 on commissure. Seed nearly terete.

1. *Ammi visnaga* (L.) Lam.

Plants up to 12 dm. tall; rays of umbel numerous, arising from a disk; pedicels arising from disks; flowers irregular; fruit (Fig. 24) ovoid to oblong-ovoid, 2–2.5 mm. long; ribs equal.—Introduced.

Gerald McCarthy collected this plant on ballast at Wilmington in 1892 (identified as *Discopleura costata*). It probably did not become established since no other collections are known from there, and recent collecting in the same area failed to disclose it. Williamson's collection marked *Ammi visnaga* (Sept., 1900; NY) is *Ptilimnium costatum*.

DISTRIBUTION: Waste-places around seaports. N. C., Fla., and Ala. (re-ported).

SPECIMENS CITED: ALABAMA: Mobile, reported by Mohr. FLORIDA: County not given, Curtiss 6860 (GH). NORTH CAROLINA: New Hanover, McCarthy, June, 1892 (US).

26. SIUM L.

Glabrous, caulescent, branching perennials. Roots fibrous. Leaves usually pinnate or pinnately decompound, sometimes much dissected. Umbels compound, opposite leaves. Bracts simple, entire or variously cut; bractlets simple, entire. Flowers mostly regular. Calyx-teeth obsolete or prominent. Petals white, spreading, recurved at tips. Stylopodium depressed. Ovary and fruit laterally flattened, ribbed. Carpophore filiform, usually split to base, sometimes not separating from mericarps. Oil-tubes variable, 1–3 between ribs and 2–several on commissure. Seed subterete.

1. *Sium suave* Walt. (*S. cicutaefolium* Schrank) Water Parsley, Water Parsnip, Hemlock.

Plants up to 2 mm. tall; adventitious roots sometimes arising from lower nodes; stem sharply angular; leaves may be dimorphic, most leaves pinnate, the lower leaves (sometimes submerged) may be pinnately dissected; blades lanceolate or linear, acute, regularly serrate; rachis of leaf septate, hollow; rays 6–20, longest about 3.5 cm.; calyx-teeth linear to ovate; fruit (Fig. 25) ellipsoid to oblong, 2–3 mm. long; ribs primary, alike.—Native. Flowers in summer and fall.

DISTRIBUTION: Very wet places along streams and in fresh or salt water marshes; coastal plain, sometimes pied. Fla., Nev., and Calif., north to Newf. and B. C.; in Southeast (Map XII), Ala., Fla., La. (?), N. C., S. C., and Tenn.

SPECIMENS CITED: ALABAMA: Mobile, Mohr, no number or date (US). FLORIDA: County and date not given, Chapman (PH). GEORGIA: None. LOUISIANA: County and date not given, Hale, ? after state. MISSISSIPPI: None. NORTH CAROLINA: Brunswick, Wells, Aug. 27, 1947 (NCS); Carteret, Rogers 34166 (DUKE); Chowan, Rodgers 557C (NCU); Craven, Rodgers 849C (NCU); Dare, Radford & Stewart 865 (NCU); Durham, Hueske, May 3, 1947 (NCU); Henderson, Rodgers 680C (NCU); Johnston, Rodgers 182C (NCU); Martin, Alexander, July 28, 1923 (NCU); New Hanover, Rodgers 867C (GA, NCU, NY, US); Onslow, Godfrey 6395 (GH, US); Perquimans, Rodgers 550C (DUKE, GA, NCS, NCU, NY, US). SOUTH CAROLINA: Berkeley, Godfrey & Tryon 487 (DUKE, GH, NY, US); Clarendon, Stone 515 (PH); Georgetown, Godfrey & Tryon 1056 (DUKE, GH, NY, TENN, US). TENNESSEE: Lake, Shanks 3171 (TENN).

27. CICUTA L. Water Hemlocks.

Tall, glabrous, branching perennials. Roots fleshy. Leaves decompound, blades broad, veins ending near notches between the teeth. Umbels large, compound, opposite the leaves or cymose. Bracts absent or few; bractlets simple. Flowers regular, perfect and staminate. Calyx-teeth distinct. Petals white, spreading,

recurved at tips. Stamens longer than petals. Styles shorter than petals. Stylopodium broad. Ovary and fruit laterally flattened; fruit ribbed. Carpophore split to base; oil-tubes solitary between ribs, 2 on commissure. Seed nearly terete, face concave to plane, often sulcate under oil-tubes.

Fruit not constricted at commissure; lateral ribs larger than others; ribs broader or narrower than intervals between them; leaflets tending to be thin and to have angular teeth ..... 1. *C. maculata*

Fruit constricted at commissure; ribs appearing about equal, broader than intervals between them; leaflets tending to be thicker, to have more reticulate venation, and to have rounded teeth ..... 2. *C. mexicana*

1. *Cicuta maculata* L. Water Hemlock, Poison Parsnip, Musquash Root, Cowbane, Beaver-poison.

Plants up to 18 dm. tall; leaves ternately or pinnately decompound; leaflets lanceolate, ovate, or elliptic, coarsely serrate, acuminate to acute at apex, tapering or oblique at base; rays 12–26; calyx-teeth acute; fruit (Fig. 26) ovoid or ellipsoid, 2–4 mm. long; lateral ribs together forming a broad band at commissure (wedge-shaped in cross section); seed sulcate under oil-tubes.—Native. Plant poisonous, especially roots; dangerous to cattle. Flowers in late spring to fall.

C. maculata is distinct in the heart of its range, but is not always distinct where it overlaps with the range of *C. mexicana*. *C. mexicana* seems to be most distinct in Florida where the combination of fruit and leaf characters is fairly constant. In N. C., plants are sometimes found having the typical fruits of *C. mexicana* and vegetative characters of *C. maculata*.

It is possible that the status of these two entities will be changed when they are better known. Whether there is hydridization or whether *C. mexicana* is really an extreme expression of a variable *C. maculata* is not known. Part of the confusion might be solved by knowing the plants better in the field. There is little herbarium material with mature fruits and even less with representative leaves. The plants are so large that they do not lend themselves very well to good representative preservation. Most collectors simply cut off the inflorescence to which is attached a few reduced upper leaves.

DISTRIBUTION: Swamps and near streams; mts., pied., and coastal plain. Fla. to Tex., north to E. Can., N. D., and Alas. (reported by Anderson, 1942); in Southeast (Map XII), all states except Ala. (probably present) and Miss. (reported).

SPECIMENS CITED: FLORIDA: Alachua, O'Neill, Jan., 1925 (FLA); Clay, West & Arnold, July 15, 1947 (FLA); Lake, Hitchcock, 1894 (FLA). GEORGIA: Gordon, Leeds 2185 (PH); Gwinnett, Small, July 20, 1893 (NY); Madison, Duncan 9854 (GA, NCU); Richmond, Cuthbert, July 10, 1901 (FLA). LOUISIANA: Natchitoches, Palmer (US); Rapides, Hale, no number or date (PH). MISSISSIPPI: Reported by Brown & Lowe. NORTH CAROLINA: Alamance, Rodgers 367C (NCU); Beaufort, Rodgers 355C (NCU); Bladen, Fox & Whitford 1848 (NCS);

Buncombe, Oosting 34464 (DUKE, PH); Caldwell, Rodgers 839C (NCU); Camden, Rodgers 538C (NCU); Carteret, Rogers 3416a (DUKE); Caswell, Rodgers 386C (NCU); Chatham, Rodgers 435C (NCU); Cherokee, Rodgers, 619C (NCU); Chowan, Godfrey 5381 (GH, US); Clay, Rodgers 615C (NCU); Currituck, Rodgers 531C (NCU); Dare, Rodgers 525C (NCU); Durham, Rodgers 482C (NCU); Forsyth, Schallert 9442 (DUKE); Gates, Correll 2244 (DUKE); Granville, Rodgers 424C (NCU); Guilford, Rodgers 374C (NCU); Harnett, Rodgers 477C (NCU); Haywood, Rodgers 698AC (NCU); Henderson, Rodgers 670C (NCU); Hertford, Rodgers 561C (NCU); Macon, Rodgers 605C (NCU); Madison, Rodgers 693C (NCU); McDowell, Rodgers 713C (NCU); Mecklenburg, Correll 3029 (DUKE); Moore, Rodgers 464C (NCU); Orange, Rodgers 393C (NCU); Pamlico, Rodgers 349C (NCU); Pasquotank, Rodgers 542C (NCU); Person, Rodgers 399C (NCU); Polk, Peattie 1299B (NCU); Randolph, Rodgers 443C (NCU); Rockingham, Rodgers 382C (NCU); Stanly, Rodgers 454C (NCU); Stokes, Rodgers 381C (NCU); Swain, Rodgers 702C (NCU); Transylvania, Rodgers 633AC (NCU); Tyrrell, Rodgers 514C (NCU); Union, Correll 934 (DUKE); Wake, Rodgers 427AC (NCU); Washington, Rodgers 507C (NCU); Watauga, Stewart 1574 (NCU); Wilson, Rodgers 358C (NCU); Yancey, Rodgers 830C (NCU). SOUTH CAROLINA: Aiken, Radford 550 (NCU). TENNESSEE: Bledsoe, Sharp 1646 (TENN); Blount, Greene 4097 (TENN); Carroll, Svenson 517 (GH); Coffee, Svenson 9061 (GH, PH); Knox, Ruth 212 (GH); Lewis, King 180 (NY); Obion, Eyles 215 (TENN); Sevier, Sharp 362 (TENN); Unicoi, Price 978 (DUKE); Union, Kalter, June 19, 1936 (TENN).

2. *Cicuta mexicana* C. & R. (*C. curtissii* C. & R.; *C. maculata* var. *curtissii* [C. & R.] Fern.)

Plants coarse, up to 24 dm. tall; leaves ternately or pinnately decompound; leaflets thickish, coarsely serrate, the teeth tending to be rounded; veins tending to be much reticulate; fruit subglobose, 2–3 mm. broad and tall; seed sulcate under oil-tubes.—Native. Plant poisonous, especially roots; dangerous to cattle. Flowers from late spring to fall.

DISTRIBUTION: Swamps and near streams; chiefly coastal plain. Fla. to N. J., southwest to Tex. and Mex.; in Southeast (Map XII), all states except Tenn.

SPECIMENS CITED: ALABAMA: Lee, Earle & Baker (NY); Talladega, Pollard & Maxon 218 (GH, NY, US). FLORIDA: Alachua, West, May 18, 1937 (FLA); Brevard, Fredholm 5860 (GH, NY, US); Broward, Small 4121 (DUKE, FLA, GH, TENN, US); Citrus, Murrill, June 6, 1941 (FLA); Clay, Murrill 263 (US); Dade, Fisher 47 (US); Duval, Curtiss 6845 (GH, NY, US); Glades, Moldenke 1026 (DUKE, NY); Hillsborough, Britton & Wilson 85 (NY); Lake, Nash 1025 (GH, NY); Manatee, Cuthbert, 1926 (FLA); Orange, Davis, Aug., 1935 (FLA); Palm Beach, Small 412 (NY); Putnam, Laessle, July 23, 1940 (FLA); St. Johns, Browne A-34 (NCU); Seminole, Baker & Arnold, July 30, 1940 (FLA); Volusia, Ames, Feb. 6, 1944 (GH). GEORGIA: Clarke, Pyron, July 9, 1929 (DUKE, GH); Madison, Wiegand &

Manning 2253 (GH); Quitman, Harper 1899 (GH, US). LOUISIANA: Rapides, Correll 9992 (DUKE); St. Tammany, Drummond, 1832 (US); Terrebonne, Wurzlow, Sept. 4, 1913 (NY). MISSISSIPPI: Reported by Lowe. NORTH CAROLINA: Avery, Kelsey 94 (US); Brunswick, Rodgers 891AC (NCU); Carteret, Rodgers 855C (NCU); Caldwell, reported by Rydberg; Columbus, Rodgers 883C (NCU); Craven, Rodgers 859C (NCU); Currituck, Godfrey 5293 (GH); Henderson, Rodgers 705C (NCU); New Hanover, Rodgers 868C (NCU); Onslow, Rodgers 875C (NCU); Richmond, Rodgers 590C (NCU). SOUTH CAROLINA: Berkeley, Hunt 1285a (CLEMS); Charleston, Alexander, July 29, 1915 (US). TENNESSEE: None.

28. PTILIMNIUM Raf. Mock Bishop's-weeds.

Glabrous, erect, branching annuals. Roots fibrous. Leaves decompound, the ultimate divisions filiform or linear. Umbels compound, opposite leaves. Bracts simple to pinnate; bractlets simple. Flowers regular. Calyx-teeth distinct. Petals white, spreading, recurved at tips. Stylopodium conic. Ovary laterally flattened. Fruit somewhat laterally flattened, ribbed; ribs equal. Carpophore split at tip to near the base. Oil-tubes solitary between the ribs, 2 on commissure. Seed subterete to dorsally flattened.

Leaves with divisions loosely arranged; styles in flower or fruit about equal or shorter than stylopodium; stamens slightly longer than petals.....1. *P. capillaceum*
Leaves with divisions so densely arranged that they appear bushy; styles in flower or fruit more than twice as long as stylopodium; stamens at least twice length of petals
2. *P. costatum*

1. *Ptilimnium capillaceum* (Michx.) Raf. Mock Bishop's-weed, Herb-William, Bullwort.

Plants up to 9 dm. tall; umbels usually many; rays 2–20, longest 2.5 cm. long or less, rarely 3.5 cm.; bracts pinnate and tripartite, rarely single or forked; styles shorter than petals; ovary ribbed; fruit (Fig. 27) ovoid, 2–3 mm. long; band of cork between lateral ribs; carpophore split almost to base, appearing split only at apex where the halves diverge.—Native. Flowers in spring and summer.

Previously the corky band at the commissure was described as a part of the lateral ribs. The position taken here is that the ribs and corky bands are distinct and not a single structure. That is borne out by looking at sections of green fruits which show the mass of cork distinctly separated from the ribs.

DISTRIBUTION: Usually in open bottom land, low pastures, and road ditches; pied. and coastal plain. Fla. to Tex., north to Mass. and Kans.; in Southeast (Map XI), all states.

SPECIMENS CITED: ALABAMA: Lee, Pollard & Maxon 57 (NY, US); Mobile, Mackensie 4011 (NY); Walker, Smith, Aug., 1877 (US). FLORIDA: Common; specimens from 33 counties examined (records omitted to save space). GEORGIA: Chatham, Eyles 4354 (DUKE); Clarke, Pyron, July 4, —— (DUKE); Cobb,

Biltmore Herb. 216d (US); Columbia, Duncan 9730 (FLA); De Kalb, Pennell 4055 (NY); Dougherty, Thorne 4996 (US); Jasper, collector unknown, 1846 (PH); Madison, Duncan 9852 (GA, NCU); Richmond, Radford 599 (NCU); Thomas, Small, May 28–June 6, 1885 (NY). LOUISIANA: Calcasieu, Mackenzie 519 (NCU); Jeff Davis, Palmer 7645 (NY); Lafayette, Correll 9427 (DUKE); Livingston, Correll 9157 (DUKE); Orleans, Waite, June 2, 1885 (US); Plaquemines, Langlois, June, 1886 (NY); Rapides, Ball 597 (GH, NY, US); St. Tammany, Anect 58 (US). MISSISSIPPI: Forrest, collector unknown, June 9, 1941 (NY); Harrison, Baker, April 27, 1898 (US); Jackson, Tracy 6391 (NY, US); Madison, McDougall 1382 (US). NORTH CAROLINA: Beaufort, Rodgers 495C (NCU); Bertie, Rodgers 559C (NCU); Bladen, Biltmore Herb. 988a (US); Brunswick, Godfrey 49812 (NCS); Cabarrus, Rodgers 767C (NCU); Camden, Rodgers 539C (NCU); Carteret, Godfrey 49807 (NCS); Caswell, Rodgers 387C (NCU); Catawba, Correll 2809 (DUKE); Chatham, Rodgers 436C (NCU); Chowan, Kearney 1911 (US); Columbus, Rodgers 884C (NCU); Craven, Blomquist 11235 (DUKE); Cumberland, Biltmore Herbarium 2161 (US); Currituck, Rodgers 532C (NCU); Dare, Rodgers 526C (NCU); Durham, Rodgers 481C (NCU); Edgecombe, Rodgers 487C (NCU); Franklin, Rodgers 421C (NCU); Gaston, Rodgers 741C (NCU); Gates, Rodgers 546C (NCU); Greene, Correll 1340 (DUKE); Harnett, Rodgers 474C (NCU); Hyde, Rodgers 520C (NCU); Johnston, Rodgers 473C (NCU); Jones, Rodgers 346C (NCU); Lincoln, Correll 2904 (DUKE); Martin, Rodgers 497C (NCU); Moore, Rodgers 467C (NCU); Montgomery, Rodgers 456C (NCU); Nash, Sample 14 (DUKE); New Hanover, Wells & Shunk, May 14, 1937 (NCS); Northampton, Rodgers 566C (NCU); Onslow, Rodgers 864C (NCU); Pasquotank, Rodgers 541C (NCU); Pender, Rodgers 872C (NCU); Perquimans, Rodgers 549C (NCU); Pitt, Rodgers 494C (NCU); Richmond, Wiegand & Manning 2286 (GH); Robeson, Rodgers 342C (NCU); Rowan, Rodgers 447C (NCU); Scotland, Rodgers 575C (NCU); Stanly, Rodgers 455C (NCU); Tyrrell, Rodgers 511C (NCU); Union, Correll 937 (DUKE); Wake, Rodgers 461C (NCU); Washington, Rodgers 503C (NCU); Wilson, Sample 13 (DUKE). SOUTH CAROLINA: Aiken, Ravenel, July, 1869 (US); Anderson, Davis 1907 (US); Charleston, Hunt 4745 (CLEMS); Darlington, Smith 846 (NCU); Georgetown, Godfrey & Tryon 69 (DUKE, GH, NY); Greenwood, Biltmore Herb. 2161C (US); Greenville, collector unknown, June 16, 1937 (FUR); Horry, Coker, July 29, 1945 (NCU); Lexington, McGregor 520 (US); Spartanburg, Walker 3501 (DUKE, NCU). TENNESSEE: Chester, Sharp et al. 12780 (TENN); Giles, Svenson 8817 (GH); Hardeman, Sharp et al. 12588 (TENN); Madison, Sharp et al. 12536 (TENN); McNairy, Bain 412 (GH, NY).

2. *Ptilimnium costatum* (Ell.) Raf.

Plants up to 16 dm. tall; rays about 20–22, longest up to 5 cm. long; bracts simple and pinnate; styles long and spreading; fruit ovoid, 3–4.5 mm. long; band of cork between lateral ribs.—Native. A new interpretation is placed upon the nature of the corky commissural band (see description under *P. capillaceum*).

DISTRIBUTION: Swampy places; chiefly coastal plain. Ga. to Tex., north

to N. C. (known only from mouth of Cape Fear River) to Mo., in Southeast (Map XI), Ala., Ga., La., and N. C.

SPECIMENS CITED: ALABAMA: Etowah, Vasey, 1878 (NY). GEORGIA: Screven, collector and date unknown (GH); Walker, Harper 347 (US). LOUISIANA: West La., Hale, no number or date (NY); Winn, Correll 10042 (DUKE). NORTH CAROLINA: Brunswick, Bartram, Oct. 3, 1908 (GH); New Hanover, Radford 660 (NCU).

29. LILAEOPSIS Greene

Glabrous, creeping perennials. Roots fibrous at the nodes. Leaves clustered, reduced to hollow, septate phyllodes. Umbels small and simple, on peduncles shorter or longer than leaves. Bracts few and simple. Flowers regular. Calyx-teeth small or obsolete. Petals white, concave, not reflexed (?). Stamens and styles shorter than petals. Ovary and fruit laterally flattened or almost globose, ribbed. Carpophore absent. Oil-tubes solitary between ribs, 2 on commissure. Seed subterete.

Inflorescence longer than leaves; leaves usually less than 6 cm. long.....1. *L. chinensis*
Inflorescence shorter than leaves; leaves usually over 6 cm. long.....2. *L. carolinensis*

1. *Lilaeopsis chinensis* (L.) Kuntze (*L. lineata* [Michx.] Greene) Joint-leaf, Lilaeopsis.

Leaves spatulate, usually 1–2 at a node; peduncles 2–8 cm. long; umbels with 4–10 flowers or fruits; stylopodium conic; fruit (Fig. 28) subglobose, wide band of cork at the commissure.—Native. Flowers in summer.

The name implies an association with China which is not the case. It probably resulted from a misunderstanding of location. See description under *Ptilimnium capillaceum* for a new interpretation of the corky band at the commissure.

DISTRIBUTION: Mud of brackish or salt marshes and river banks; coastal plain. La. to Fla., north to N. S.; in Southeast (Map XI), Fla., Ga., La., N. C., and S. C.

SPECIMENS CITED: ALABAMA: None. FLORIDA: Duval, Curtiss 993 (FLA, GH, NY, US); Hillsborough, Garber, May, 1896 (US); Levy, West & Arnold, April 12, 1946 (FLA). GEORGIA: Liberty, Harper 2182 (NY, US). LOUISIANA: County not given, Braun 6202 (GH). MISSISSIPPI: None. NORTH CAROLINA: Brunswick, Radford 5198 (NCU); Carteret, Blomquist et al., July 15, 1938 (DUKE); New Hanover, Oosting 2078 (DUKE); Tyrrell, Radford & Rodgers 516C (DUKE, GA, NCS, NCU, NY, US). SOUTH CAROLINA: Charleston, Hunt, no number or date (CLEMS).

2. *Lilaeopsis carolinensis* C. & R. (*L. attenuata* [H. & A.] Fern.) Carolina Joint-leaf, Carolina Lilaeopsis.

Leaves oblong or spatulate, peduncles up to 5 cm. long; umbels with 4–15 flowers or fruits; stylopodium low; fruit ovoid, wide band of cork at commissure.—Native.

DISTRIBUTION: Wet places; coastal plain. Known from Ark., La., N. C., S. C., Va., and S. A.; in Southeast (Map XI). (Small gives Fla.)

SPECIMENS CITED: LOUISIANA: Orleans, Langlois, April, 1883 (NY); St. Tammany, Arsene 11893 (US). NORTH CAROLINA: Dare, Wells, July 6, 1923 (NCS); New Hanover, Williamson 148 (PH). SOUTH CAROLINA: Horry, Weatherby & Griscom 16598 (DUKE, GH, NY).

30. OXYPOLIS Raf. Dropworts.

Glabrous, erect, branching perennials. Roots fibrous and tuberous. Leaves pinnate, ternate, or reduced to hollow phyllodes. Umbels compound, opposite bract-like leaves or occasionally cymose. Bracts and bractlets simple and narrow or absent. Flowers regular. Calyx-teeth distinct. Petals white, yellowish, or purple, recurved at tips. Stylopodium conic. Ovary laterally flattened, smooth. Fruit dorsally flattened, ribbed. Ribs alike, the laterals closely applied to wings at the commissure. Carpophore split to base. Oil-tubes solitary between ribs, 2 on commissure. Seed dorsally flattened.

Previously the corky wings at the commissure of the fruits were described as a part of the lateral ribs (wings were described as nerved on the dorsal side). The position taken here is that the ribs and wings are distinct and not a single structure. They are believed to be comparable to the corky commissural bands of some species of genera like *Ptilimnium* and *Lilaeopsis*.

Leaves reduced to septate phyllodes.
  Sheaths of lower leaves obviously longer than 1 cm.; body of fruit thicker than thin lateral wings ..... 1. *O. filiformis*
  Sheaths of all leaves less than 1 cm. long; body of fruit thinner than thick corky wings ..... 2. *O. canbyi*

Leaves with blades.
  Leaves pinnate; veins netted; most leaf blades sessile or nearly so ..... 3. *O. rigidior*
  Leaves ternate or simpler; veins parallel; leaf blades on distinct petiolules, sometimes longer than blades ..... 4. *O. ternata*

1. *Oxypolis filiformis* (Walt.) Brit. Water Dropwort.

Plants up to 20 dm. tall; roots fibrous; stems hollow shells; septations of phyllodes with tiny projections in depressions, these representing reduced leaflets; rays 6–15, usually 9–12; pedicels of umbelets 4–21, usually 15–18; bracts and bractlets simple; flowers perfect and staminate, first umbel usually predominantly perfect; petals white; fruits ovoid, obovoid, or ellipsoid.—Native. Flowers in summer and fall.

DISTRIBUTION: Open, wet places; chiefly coastal plain. Fla. to Tex. and Va.; W. I.; in Southeast (Map XIII), all states except Tenn.

SPECIMENS CITED: ALABAMA: Cullman, Mohr, 1887 (US); Mobile, Browne A-43 (NCU). FLORIDA: Alachua, West, Aug. 19, 1927 (FLA); Baker, Murrill,

Sept. 22, 1940 (FLA); Bradford, Murrill, no number or date (FLA); Brevard, Fredholm 5661 (GH); Broward, Small 4434 (NY); Calhoun, West, Sept. 9, 1931 (FLA); Charlotte, Frye, Sept. 3, 1946 (FLA); Clay, Totten, Sept. 7, 1945 (NCU); Collier, Scull, Sept. 1, 1937 (FLA); Dade, Palmer 195 (GH, NY, PH, US); De Soto, West, Sept. 23, 1938 (FLA); Duval, Nash 2596 (GH, NCU, NY, PH, US); Flagler, West & Arnold, Oct. 10, 1940 (FLA); Franklin, Biltmore Herb. 3621b (GH, NY, US); Gadsden, Foster 118 (FLA); Gilchrist, West & Arnold, Oct. 5, 1940 (FLA); Gulf, Small & West, Aug. 8, 1935 (FLA); Hardee, Kirk, Oct. 10, 1942 (FLA); Hendry, Davis, Oct. 8, 1941 (FLA); Highlands, Schallert 891 (FLA); Hillsborough, Emmel & West, Nov. 22, 1949 (FLA); Jackson, Wiegand & Manning 2284 (GH); Lee, Davis, Sept. 13, 1947 (NCS); Leon, Rugel, Aug., 1843 (NY); Liberty, West & Arnold, July 23, 1940 (FLA); Manatee, Tracy 7091 (GH, NY, US); Monroe, Moldenke 363a (DUKE, NY); Okeechobee, Davis, Aug. 21, 1934 (FLA); Orange, O'Neill, Sept. 24, 1929 (US); Osceola, Singeltary, Oct. 10, 1937 (DUKE, NCS); Putnam, West, Sept. 24, 1940 (FLA); Santa Rosa, Curtiss, Nov., 1901 (US); St. Johns, Reynolds, Aug. 1874 (NY); Volusia, Butts, July 21, 1943 (GH); Wakulla, Rugel 285 (US); Walton, Hocking, Aug. 28, 1940 (FLA); Washington, Senner, Aug. 31, 1942 (FLA). GEORGIA: Baker, Ford & Thorne, Aug. 29, 1946 (TENN); Berrien, Harper 659 (GH, NY, US); Chatham, Hopkins 33 (NY); Dooly, Harper 2220 (GH); Emanuel, Harper 993 (GH, NY, US); Lee, Harper 1147 (GH, NY, US). LOUISIANA: Orleans, Drummond (GH); St. Tammany (?), Brown 7184 (GH); Tangipahoa, Correll 10534 (DUKE). MISSISSIPPI: Harrison, Tracy 7015 (GH); Jackson, Seymour 9183170 (GH, NCU); Tishomingo, Rhoades, Sept., 1940 (GH). NORTH CAROLINA: Brunswick, Rodgers 891C (GA, NCU, NY); Columbus, Rodgers 882C (GA, NCU, US); Craven, reported by Croom; Cumberland, Rankin, Aug. 23, 1940 (NCU); New Hanover, Godfrey & Wells 6201 (GH, NCS, US); Pender, Rodgers 871C (DUKE, GA, NCS, NCU, NY, US). SOUTH CAROLINA: Berkeley, Hunt 1072b (CLEMS); Charleston (?), Porcher, no number or date (NY); Georgetown, Godfrey & Tryon 1057 (GH, NY, US); Hampton, Wiegand & Manning 2283 (GH); Orangeburg, Eggleston 5022 (GH, NY). TENNESSEE: None.

2. *Oxypolis canbyi* (C. & R.) Fern.

Plants up to 9 dm. tall; fruit almost orbicular to oblong-ellipsoid, wings thicker than body of fruit.—Native. Flowers in summer and fall.

This plant is smaller than *O. filiformis* which it most closely resembles, and its range extends further north. It is known from only two locations, but is included here because of the possibility of its being found in North Carolina.

DISTRIBUTION: Open, wet places; coastal plain. Known from Ga. (Map XIII) and Del.

SPECIMENS CITED: DELAWARE: Sussex, Canby, Sept. 16, 1891 (US). GEORGIA: Lee, McVaugh 5235 (DUKE).

3. *Oxypolis rigidior* (L.) Raf. (*O. turgida* Small; *O. rigidior* var. *ambigua* [Nutt.] Robins.) Cowbane, Hemlock Dropwort, Water Dropwort, Pig Potato, Water Parsnip.

Plants up to 16 dm. tall; roots usually tuberous toward distal end; leaflets usually 7–11 (3–13), rarely 4 leaflets from same level of rachis, most sessile or subsessile, lanceolate, elliptic, oblong, linear, ovate, and obovate, mostly acute at apex, entire or with large teeth toward distal end or on one side of blade; rays 12–45, very slender; pedicels slender, numerous; petals white; stylopodium green; fruit (Fig. 29) ovoid, ellipsoid, or oblong.—Native. Flowers in summer and fall.

Plants with entire leaves have been described as a variety. That status is not recognized at present (Allard, 1944). There is a tendency for plants growing in the open to have slender, entire leaves; however, entire and toothed leaves have been seen on the same plant.

DISTRIBUTION: Open or semi-open, wet places; mts., pied., or coastal plain. Fla. to Tex., north to N. Y. and Ont. (Macoun, 1901; NY); in Southeast (Map XIII), all states.

SPECIMENS CITED: ALABAMA: Baldwin, Tracy 8632 (GH, NY, US); Jackson, Porter, July 15, 1936 (GH); Jefferson, Vasey, 1897 (NY, PH); Lee, Earle & Baker 1237 (NY); Mobile, Mohr, July, 1875 (US). FLORIDA: Gadsden, Biltmore Herb. 4698 (GH, NY, US). GEORGIA: Clarke, Pyron, Oct. 18, 1929 (DUKE); Coffee, Harper 722 (NY, US); Dade, Cronquist 4827 (FLA, GA, US); Habersham, Small, Aug. 20–Sept. 3, 1894 (NY); Rabun, Duncan 10485 (GA, NCU); Randolph, Harper 1784 (GH, NY, US); Richmond, Cuthbert, Sept. 18, 1907 (FLA). LOUISIANA: Feliciana (East or West ?), Carpenter, 1842 (US); Madison (?), collector unknown, 1846 (PH); Natchitoches, Palmer 8814 (NY); Rapides, Hale, no number or date (PH, US); Webster, Correll 10308 (DUKE). MISSISSIPPI: Jackson, Earle, Oct. 27, 1889 (NY); Wayne, Pollard 1246 (GH, NY, US). NORTH CAROLINA: Alleghany, Rodgers 799C (NCS, NCU); Ashe, Rodgers 805C (NCU); Avery, Rodgers 821C (DUKE, NCU); Bladen, reported by Harper; Brunswick, Godfrey 10102 (NCU); Caldwell, Rodgers 820C (GA, NCU); Clay, Rodgers 611C (NCU); Columbus, Rodgers 885C (NCU, US); Dare, Radford 5083 (NCU); Forsyth, Schallert, Sept. 11, 1941 (NY); Haywood, Rodgers 694C (NCU); Henderson, Rodgers 642C (NCU); Jackson, Rodgers 594C (GA, NCU); Lee, Godfrey 6922 (GH, NCS); Macon, Rodgers 606C (NCU); Mitchell, Rodgers 828C (DUKE, NCU); Nash, Godfrey & Kerr 6657 (DUKE, NCS); New Hanover, reported by Wood & McCarthy; Onslow, Godfrey 6457 (GH, NCS, US); Orange, Schweinitz, no number or date (PH); Pender, Rodgers 873AC (NCU, NY, US); Rowan, Small, Aug. 18–27, 1894 (NY, PH); Rutherford, Rodgers 732C (NCU); Stokes, Godfrey & Fox 48590 (NCS); Swain, Ashe, Sept., 1893 (NCU); Transylvania, Rodgers 632BC (NCU); Wake, Godfrey 6741 (GH), Oct., 1937 (NCS); Watauga, Rodgers 813C (NCU); Yancey, Rodgers 833C (NCU). SOUTH CAROLINA: Aiken, Ravenel, Aug., 1869 (US); Anderson, Davis 7705 (US); Charleston, Blackman, no number or date (PH); Georgetown, Godfrey

8239 (DUKE, NY, TENN); Oconee, House 3064 (NY); Pickens, Rodgers 267 (DUKE). TENNESSEE: Bledsoe, Shanks et al. 3579 (TENN); Blount, Sharp & Underwood 4563 (TENN); Carter, Rydberg 8204 (NY); Chatham, Svenson 283 (GH, PH); Coffee, Svenson 8963 (GH); Grainger, Brown 11C (TENN); Unicoi, Price 989 (DUKE); Wayne, Svenson 4314 (GH).

4. *Oxypolis ternata* (Nutt.) A. Heller Ternate Water Dropwort.

Plants very slender, up to 9 dm. tall; roots tuberous, club-shaped or obovoid; stem mostly less than 2 mm. in diameter, rarely 4 mm.; blades 1, 2, or 3 to a leaf, veins parallel; petioles up to 3.7 dm. long; petiolules distinct, even if only one blade, sometimes as long as blade; umbels mostly 2–4, rarely 8; rays 5–12, long and slender; bracts absent or 1–4 and simple; flowers white with yellowish and rose tint; fruit ellipsoid, obovoid, or ovoid.—Native. Flowers in fall.

This plant is probably more abundant than the few herbarium specimens indicate. It is particularly difficult to locate because its slender, grassy appearance blends with the background of grasses in the savannas. In addition, it makes a sudden appearance in late fall. A fruitless attempt was made to locate it on the big savanna at Burgaw in Sept., 1949, but a week later it was abundantly present almost everywhere. The earliest records of flowers are in September.

DISTRIBUTION: Savannas; coastal plain. Fla. to Va.; Tex. (Cory 49902; GH); in Southeast (Map XIII), Fla., Ga., S. C., and N. C.

SPECIMENS CITED: FLORIDA: Calhoun, Small et al. 11011 (FLA); Franklin, Curtiss 1010 (GH, NCU, PH, US); Liberty, Ford et al., Nov. 11, 1930 (PH). NORTH CAROLINA: Brunswick, Rodgers 888C (DUKE, GA, NCS, NCU, NY, US); Craven, Croom, no date or number (PH); Duplin, Rodgers 877C (DUKE, GA, NCU, NY, US); Harnett, Godfrey 50122 (FLA, NCS, NCU); Pender, Rodgers 892C (NCU). SOUTH CAROLINA: Darlington, Norton, Oct. 30, 1921 (NCU).

31. ANGELICA L. Angelicas.

Large, glaucous, glabrous, or pubescent, branching perennials. Taproots. Leaves mostly 2- or 3-pinnate with all basal leaflets having stalks and each successively higher leaflet with shorter stalk until the leaflets sessile; upper leaves with conspicuously "inflated" petioles, blades reduced or absent. Umbels compound, opposite leaves (sometimes bract-like) or cymose. Bracts absent or 1–3, linear to "inflated"; bractlets present. Flowers tending to be slightly irregular. Calyx-teeth absent or small. Petals white, greenish, pink, or purple; spreading, recurved at tips. Stylopodium large, low-conic. Ovary laterally flattened. Fruit dorsally flattened and ribbed, lateral ribs extended as wings. Carpophore split to base. Oil-tubes 1-several between ribs, 4-several on commissure. Seed dorsally flattened.

Ovaries and fruits pubescent; entire inflorescence covered with dense short pubescence; petals white ..... 1. *A. venenosa*

Ovaries and fruits glabrous; inflorescence essentially glabrous except near attachment of rays and pedicels; flowers greenish ..... 2. *A. triquinata*

1. *Angelica venenosa* (Greenway) Fern. (*A. villosa* [Walt.] B. S. P.) Angelica, Hairy Angelica.

Plants up to 18 dm. tall, practically glabrous except near inflorescence; leaflets thickish, oblong, elliptic, or lanceolate, obtuse or acute at apex, obtuse, acute or oblique at base, serrate or crenate-serrate, sometimes cut to midrib; rays 12–35, usually over 20; umbelets crowded with 25–35 flowers; bractlets 6–7; calyx-teeth distinct; petals with pubescence on under side of veins; fruit oblong to almost orbicular; dorsal and intermediate ribs shallow, lateral ribs deep and forming wings.—Native weed. Flowers from spring to fall.

DISTRIBUTION: Roadsides, abandoned fields, savannas, and woods; mts., pied., and coastal plain. Fla. to Miss. and Ark., north to Mass. and Minn.; in Southeast (Map XIV), all states except La.

SPECIMENS CITED: ALABAMA: Autauga, Mohr, July, 1881 (US); Baldwin, Tracy 8052 (GH, NY, US); Cullman, Mohr, no number or date (US); Jackson, Porter, June 15, 1938 (GH); Lee, Earle & Baker, Aug. 15, 1897 (NY); Macon, Wiegand & Manning 2244 (GH); Tuscaloosa, Harper 3089 (GH, NY, PH). FLORIDA: Jackson, Curtiss, no number or date (GH). LOUISIANA: None. MISSISSIPPI: Wayne, Pollard 1246A (NY, US). NORTH CAROLINA: Alamance, Rodgers 779C (NCU); Alexander, Rodgers 752C (NCU); Alleghany, Rodgers 798C (NCU); Anson, Rodgers 778C (NCU); Avery, Rodgers 825C (NCU); Buncombe, Rodgers 687C (NCU); Burke, Rodgers 723C (NCU); Cabarrus, Rodgers 765C (NCU); Caldwell, Rodgers 840C (NCU); Caswell, Godfrey 5550 (GH); Catawba, Rodgers 750C (NCU); Chatham, Rodgers 484C (NCU); Cherokee, Rodgers 621C (NCU); Clay, Rodgers 610C (NCU); Columbus, Rodgers 886C (NCU); Davie, Rodgers 761C (NCU); Durham, Blomquist 4372 (DUKE); Forsyth, Rodgers 377C (NCU); Gaston, Rodgers 740C (NCU); Graham, Rodgers 626C (NCU); Granville, Rodgers 404C (NCU); Halifax, Rodgers 419C (NCU); Harnett, Rodgers 478C (NCU); Haywood, Rodgers 696C (NCU); Henderson, Rodgers 641C (NCU); Hoke, Rodgers 574C (NCU); Iredell, Rodgers 754C (NCU); Jackson, Rodgers 593C (NCU); Johnston, Rodgers 472C (NCU); Lee, Rodgers 479C (NCU); Lincoln, Rodgers 748C (NCU); Macon, Rodgers 588C (NCU); Madison, Rodgers 688C (NCU); McDowell, Rodgers 715C (NCU); Mecklenburg, Rodgers 746C (NCU); Mitchell, Rodgers 827C (NCU); Moore, Rodgers 466C (NCU); Onslow, Godfrey 6462 (GH, NCU, US); Orange, Rodgers 390C (NCU); Person, Rodgers 396C (NCU); Polk, Rodgers 647C (NCU); Richmond, Rodgers 579C (NCU); Rutherford, Rodgers 670C (NCU); Sampson, Godfrey 5887 (GH); Stanly, Rodgers 450C (NCU); Stokes, Rodgers 785C (NCU); Surry, Rodgers 788C (NCU); Transylvania, Rodgers 599C (NCU); Wake, Rodgers 469C (NCU); Washington, Rodgers 504C (NCU); Watauga, Rodgers 811C (NCU); Wilkes, Rodgers 796C (NCU); Yadkin, Rodgers 842C (NCU); Yancey, Rodgers 831C (NCU). SOUTH CAROLINA: Aiken, Radford 555 (NCU); Anderson, Duncan 9967 (GA, NCU); Berkeley, Ravenel, no number or date (GH); Darlington, Smith 899 (NCU); Greenville, Peattie

1260A (NCU); Lexington, Godfrey & Tryon 1213 (DUKE, GA, PH, TENN, US); Pickens, Rodgers 243 (DUKE); Williamsburg, Godfrey & Tryon 457 (GH, US). TENNESSEE: Bledsoe, Iltis 3401 (TENN); Carroll, Svenson 461 (GH); Carter, Rydberg 8184 (TENN); Cocke, Kearney 705 (NY, US); Coffee, Clebsch 4756 (TENN); Davidson, Svenson & Shaver 9629 (GH); Hamilton, Rhoades, Aug., 1940 (GH); Knox, Ruth, July, 1895 (GH); Roane, Jennison & Anderson, July 14, 1929 (GH); Robertson, Eggert, July 13, 1897 (NY, US); Sevier, Jennison 458 (TENN); Unicoi, Price 964 (DUKE); Union, Morrison, June 21, 1937 (TENN).

2. *Angelica triquinata* Michx. (*A. curtisii* Coult.) Curtis' Angelica, Filmy Angelica.

Plants coarse, up to 18 dm. tall, glaucous or glabrous, with strong odor; leaflets thin, ovate to lanceolate, acuminate at apex, teeth large and acuminate or acute, sometimes cut to midrib; umbels mostly glabrous or faintly hairy, pubescent below attachment of rays and pedicels; rays 10–20; umbelets with 25–50 flowers; bractlets 6–12; calyx-teeth absent; stamens and stylopodium green; fruit ovoid; dorsal and intermediate ribs shallow, lateral ribs extended as wings.—Native. Flowers in summer and fall.

In the summer these plants present a striking appearance near the top of Mt. Mitchell where they are the most conspicuous plants in the extensive open areas.

DISTRIBUTION: Along streams and in open or semi-open places; mts. N. C. and Tenn. to Penn. (also known from boundary between N. C. and Ga. and reported from mts. of S. C.); in Southeast (Map XIV), Ga., N. C., and Tenn.

SPECIMENS CITED: GEORGIA: Thomas Bald on N. C.-Ga. boundary, Small, Aug. 19, 1893; Mts. of Ga., Buckley, no number or date (NY). NORTH CAROLINA: Ashe, Rodgers 806C (NCU); Avery, Rodgers 822C (NCU); Buncombe, Britton, Sept. 18, 1885 (NY); Caldwell, Rodgers 819C (NCU, NY); Clay, Rodgers 612C (NCS, NCU); Graham, Rodgers 622C (DUKE, NCU); Haywood, Rodgers 698C (DUKE, GA, NCU); Macon, Rodgers 603C (NCU, NY); Madison, Rodgers 690C (NCU); Mitchell, Chickering, Aug. 5, 1880 (US); Swain, Harbison & Totten, Sept. 15, 1932 (NCU); Watauga, Rodgers 814C (NCU, US); Yancey, Rodgers 720C (DUKE, GA, NCU, NY, US). SOUTH CAROLINA: Reported by Ives. TENNESSEE: Carter, Britton, Sept. 9, 1895 (NY); Cocke, Kearney 706 (NY); Sevier, Jennison 4683 (TENN).

32. CONIOSELINUM Hoff.

Glabrous, erect, branching perennials. Taproots or clustered fleshy roots. Umbels compound. Bracts absent or several; bractlets with hyaline margins. Calyx-teeth obsolete. Petals white with recurved tips. Styles shorter than petals. Stylopodium conic. Fruits dorsally flattened, ribbed; lateral ribs deepest. Carpophore split almost to base. Oil-tubes 1–4 between ribs, 2–several on commissure. Seed dorsally flattened.

1. *Conioselinum chinense* (L.) B. S. P. Hemlock Parsley.

Plants up to 15 dm. tall, sparingly branched; leaflets pinnatifid with the segments mostly acute; sheaths of upper leaves conspicuously "inflated"; umbels opposite the leaves, rays 9–30; flowers with tendency to irregularity; stamens longer than petals; fruit (Fig. 31) ovoid or oblong-ellipsoid, 4–6 mm. long; dorsal and intermediate ribs acute, about equal, the lateral ribs extended into wings.—Native.

DISTRIBUTION: This plant was collected on Grandfather Mt. by Asa Gray and J. Carey in 1841. No later collections of it are known from there or any other part of the state. This may mean that the station no longer exists. According to records at hand, its distribution is from N. J., Ohio, Mo., and N. Calif., northward through Can. and Alas. into Sib. If it is not found between Penn. and Grandfather Mt., the gap is rather large.

SPECIMEN CITED: NORTH CAROLINA: Caldwell, Gray & Carey, July, 1841 (GH, NY).

33. HERACLEUM L.

Pubescent, tall, coarse biennials or perennials. Taproots or fibrous roots. Leaves pinnate or ternate, blades broad. Umbels compound, opposite leaves or cymose. Bracts absent or few; bractlets simple, numerous. Flowers tending to be irregular. Calyx-teeth obsolete. Petals mostly white, spreading, recurved at tips. Stylopodium conic. Ovary and fruit usually pubescent; fruit strongly dorsally flattened and ribbed, the lateral ribs extended as wings. Carpophore split to base. Oil-tubes solitary between ribs, 2–4 on commissure. Endocarp stony. Seed dorsally flattened.

1. *Heracleum lanatum* Michx. (*H. maximum* Bart.) Cow Parsnip, Masterwort.

Wooly perennials, up to 27 dm. tall; leaves large, ternate; leaflets up to 40 cm. long, ovate to orbicular, cordate at base, coarsely toothed and variously incised; main veins palmate, sheaths of upper leaves greatly "inflated"; rays 6–30; petals with branching veins, outer usually larger and often 2-cleft; ovary wooly; fruit (Fig. 32) obovate to obcordate, 8–13 mm. long; dorsal and intermediate ribs filiform; oil-tubes easily visible on outside, extending about ½ distance from apex.—Native. Occasionally planted as ornamental. Flowers in summer.

DISTRIBUTION: Waste-places and fields; mts. of this region. N. C. to Ariz. and Calif., north to Can. and Alas.; Siberia; in Southeast (Map IV), N. C. and Tenn. (reported from Ga.)

SPECIMENS CITED: GEORGIA: Reported by Mathias & Constance & Small. NORTH CAROLINA: Haywood, Blomquist 4398 (DUKE); Jackson, Oosting 3688 (DUKE); Mitchell, Merriam, Sept. 1, 1892 (US). TENNESSEE: Cocke, Kearney 707 (NCU, NY, US).

34. PASTINACA L.

Glabrous or pubescent, coarse biennials and perennials. Fleshy taproots. Stems sharply angular. Leaves pinnate or bipinnate to simple bract-like above. Upper leaves with conspicuous "inflated" sheaths and reduced blades. Umbels large, compound, opposite leaves or cymose. Bracts and bractlets absent or few and simple. Flowers regular. Calyx-teeth obsolete. Petals yellow (or red), spreading, recurved at tips. Stylopodium broad, conic. Ovary and fruit dorsally flattened. Fruit ribbed, the lateral ribs extended as wings. Carpophore split to base. Oil-tubes usually solitary between ribs, 2–4 on commissure. Seed dorsally flattened.

1. *Pastinaca sativa* L. Parsnip, Wild Parsnip, Madnep, Tank, Hart's Eye.

Plants biennial, up to 18 dm. tall; leaflets ovate to oblong, serrate, often variously cut, obtuse or acute at apexes, mostly sessile or subsessile; rays 7–30; styles short; fruit (Fig. 33) 5–6 mm. long, mostly obovate or suborbicular, dorsal and intermediate ribs filiform, alike. Introduced food plant. Flowers in summer.

DISTRIBUTION: Waste-places throughout most of U. S., but seldom seen in Southeast (Map IV).

SPECIMENS CITED: NORTH CAROLINA: Ashe, collector and date unknown (NCU); Avery, Totten, July 1, 1941 (NCU); Haywood, Rodgers 697C (NCU); Henderson, Rodgers 676C (GA, NCU); Jackson, Rodgers 633C (NCU); Polk, Peattie 801A (NCU); Yancey, Radford 2588 (NCU). SOUTH CAROLINA: Reported by Coulter & Ives.

SUMMARY

1. A survey of the Umbelliferae in North Carolina indicates the presence of 34 genera, 59 species, and 4 varieties. Of this total, 44 species and 2 varieties are native, and 15 species and 2 varieties are introduced.

2. Ranges of the following species have been extended beyond that given in Gray's *Manual of Botany* (8th ed.), Small's *Manual of the Southeastern Flora* (1933), and Mathias and Constance's monograph of the Umbelliferae in *N. A. Flora* (1944–1945): *Aegopodium podagraria* var. *variegatum*, *Angelica triquinata*, *Carum carvi*, *Chaerophyllum procumbens*, *Cicuta maculata*, *Daucus pusillus*, *Eryngium prostratum*, *Hydrocotyle sibthorpioides*, *Lilaeopsis chinensis*, *Oxypolis rigidior*, *Oxypolis ternata*, *Sanicula canadensis*, *Sanicula smallii*, *Sanicula trifoliata*, *Sium suave*, *Spermolepis divaricata*, *Taenidia integerrima*, and *Thaspium trifoliatum* var. *flavum*.

3. The following species are either new to the state or are rediscoveries of plants not collected in recent years: *Aegopodium podagraria* var. *variegatum*, *Carum carvi* (reported by Hyams, 1899), *Conium maculatum* (no previous collections known from N. C., but reported throughout U. S. by Mathias & Constance), *Daucus pusillus* (reported by Hyams, 1899), *Lilaeopsis carolinensis* (collected by Wells in 1923; previous collections in 1911 or earlier), *Sanicula trifoliata*,

Torilis japonica, and *Torilis nodosa* (reported by Hyams, 1899; rediscovered by Blomquist and Batson; to be published by Godfrey, Fox, and Blomquist in Rhodora).

4. The distribution of North Carolina species and varieties throughout the Southeast is mapped from collections made in the field in North Carolina plus collections deposited in a number of herbaria.

5. Illustrations of fruit characters of every genus except one are included.

6. The key is constructed in such a way that it is possible to identify to the genus and, in almost every case, to the species or variety whether the plant is in flower or in fruit.

7. The genera, species, and varieties are described and their habitats given.

8. Observations on the possible relationships of several genera are made.

9. Taxonomic criteria generally used as well as possible new criteria are evaluated.

ACKNOWLEDGEMENTS

I am particularly grateful to Dr. H. R. Totten for encouragement and supervision during the course of this research. I also wish to express appreciation to Dr. A. E. Radford, with whom I worked in the field and who helped find many of the plants, to Mrs. Alma Holland Beers, who has given important assistance and advice about the preparation of plates and arrangement of material for publication.

In addition, I want to express my appreciation to the curators of the herbaria listed in the text for making their facilities available on my visits or through loans and to the Highlands Biological Station and its director, Prof. Thelma Howell, for providing the facilities of the station for study and handling of specimens collected in the mountains and for the financial assistance of the Col. and Mr. John S. Sewell Fellowship. Additional financial assistance was given by the Smith Research Fund of the University of North Carolina.

The distribution maps are based on the outline map published by the McKinley Publishing Company of Philadelphia and used by permission.

BIBLIOGRAPHY

ALEXANDER, E. J. 1926. *Eryngium aquaticum*. Addisonia **11**: 43–44.

ALLARD, H. A. 1944. The status of *Oxypolis ridigior* var. *ambigua* (Nutt.) Robinson. Castanea **9**: 109–110.

American Pharmaceutical Association. 1946. The National Formulary. 8th ed. Washington.

ANDERSON, J. P. 1942. Papers on the flora of Alaska—I: The Genus Cicuta. Torreya **42**: 176–178.

BAILEY, L. H. 1949. Manual of Cultivated Plants. The Macmillan Company, New York.

BENKE, H. C. 1933. New species and forms from the central and southern United States. Rhodora **35**: 44–46.

BENTHAM, G., AND J. D. HOOKER. 1862. Genera Plantarum. Vol. I. Reeve and Company, London.

BICKNELL, E. P. 1895. The genus Sanicula in the eastern United States. Bull. Torr. Bot. Club **22**: 241–245.

——— 1897. Two new species of Sanicul- from the southern States. Bull. Torr. Bot. Club **24:** 577–582.

BLAKE, S. F. 1923. The forms of *Osmorhiza longistylis*. Rhodora **25:** 110–111.

BLOMQUIST, H. L., AND H. J. OOSTING. 1948. A Guide to the Spring and Early Summer Flora of the Piedmont. Pub. by the Authors, Durham, N. C.

BORTHWICK, H. A., MABEL PHILLIPS, AND W. W. ROBBINS. 1931. The floral development in *Daucus carota*. Amer. Jour. Bot. **18:** 784–796.

BRITTON, N. L., AND A. BROWN. 1923. An Illustrated Flora of the Northern United States, Canada, and the British Possessions. 2nd ed. New York Botanical Garden, New York.

BROWN, W. H. 1911. The plant life of Willis, Great, Little, and Long Lakes in North Carolina. Cont. U. S. Nat. Herb. **13:** 323–341.

CAIN, STANLEY A. 1945. A biological spectrum of the Great Smoky Mountains National Park. Butler Univ. Bot. Stud. **7:** 11–24.

CHAPMAN, A. W. 1897. Flora of the Southern United States. Cambridge Botanical Supply Company, Cambridge, Mass.

CHESTNUT, V. K. 1894. Principal poisonous plants of the United States. Bull. U. S. Dept. Agric. **20:** 1–60.

——— 1898. Thirty poisonous plants of the United States. U. S. Dept. Agric. Farm Bull. **86:** 1–32.

CONSTANCE, LINCOLN, AND REN HWA SHAN. 1948. The genus Osmorhiza. Univ. Calif. Pub. Bot. **23:** 151–156.

COULTER, DELLA R. 1930. Plants in South Carolina. The State Company, Columbia, S. C.

COULTER, J. M., AND C. J. CHAMBERLAIN. 1903. The Morphology of Angiosperms. D. Appleton and Company, New York.

COULTER, J. M., AND J. N. ROSE. 1888. Revision of North American Umbelliferae. Crawfordsville, Ind.

——— 1900. Monograph of the North American Umbelliferae. Cont. U. S. Nat. Herb. **7:** 1–256.

——— 1909. Supplement to the Monograph of the North American Umbelliferae. Cont. U. S. Nat. Herb. **12:** 441–451.

CROOM, H. B. 1835. Botanical communications. Amer. Jour. Sci. and Arts **28:** 165–168.

——— 1837. Catalogue of Plants Native or Naturalized in the Vicinity of New Bern, N. C. G. P. Scott and Company, New York.

——— and H. LOOMIS. 1833. Plants Observed in the Neighborhood of New Bern, N. C. Spectator Office, New Bern, N. C.

CURTIS, M. A. 1835. Catalogue of plants growing spontaneously around Wilmington, N. C. Boston Jour. Nat. Hist. **1:** 82–141.

——— 1867. A catalogue of the indigenous and naturalized plants of the State. Geol. and Nat. Hist. Surv. of N. C. **3:** 1–156.

EAMES, E. H. 1919. Another exceptional specimen of *Daucus carota*. Rhodora **21:** 147–148.

ELLIOTT, STEPHEN. 1821. A Sketch of the Botany of South Carolina and Georgia. J. R. Schenck, Charleston, S. C.

FERNALD, M. L. 1939. *Oxypolis canbyi* (Coult. and Rose), comb. nov. Rhodora **41:** 139.

——— 1940. Spermatophytes of eastern North America. Rhodora **42:** 249–276, 281–302.

——— 1940. A century of additions to the flora of Virginia. Rhodora **42:** 355–416, 419–498, 503–521.

——— 1945. Botanical specialties of the Seward Forest and adjacent areas of southeastern Virginia. Rhodora **47:** 93–204.

——— 1950. Gray's Manual of Botany, 8th ed. American Book Company.

FOX, W. B., AND R. K. GODFREY. 1949. Notes on distribution of plants. Rhodora **50:** 129–146.

GATTINGER, AUGUSTIN. 1901. Flora of Tennessee and Philosophy of Botany. State Bureau of Agriculture, Nashville, Tenn.

GRAY, ASA. 1842. Notes on a botanical excursion to the mountains of North Carolina. Amer. Jour. Sci. and Arts **42:** 1–49.

GREENE, E. L. 1889. Vegetative characters of the species of Cicuta. Pittonia **2:** 1–16.

HANSEN, A. A. 1921. Lawn pennywort: A new weed. U. S. Dept. Agric. Dept. Circ. **165:** 1–6.

HARPER, R. M. 1910. Notes on the distribution of some plants observed in traveling through the coastal plain from Georgia to New York in July 1909. Bull. Torr. Bot. Club **37:** 591–603.

———— 1910. Summer notes on the mountain vegetation of Haywood County, North Carolina. Torreya **10:** 53–64.

———— 1944. Preliminary report on weeds of Alabama. Bull. Geol. Surv. Ala. **53:** 1–275.

———— 1947. Preliminary list of Southern Appalachian endemics. Castanea **12:** 100–112.

HELLER, A. A. 1891. Notes on the flora of North Carolina. Bull. Torr. Bot. Club **18:** 186–192.

HILL, A. W. 1927. The genus Lilaeopsis: A study in geographical distribution. Jour. Linn. Soc. London Bot. **47:** 525–551.

HYAMS, C. W. 1899. The flora of North Carolina from Ranunculaceae to Salviniaceae. N. C. Agric. Expt. Sta. Bull. **164:** 291–365.

HYAMS, M. E. 1885. A preliminary list of additions to Curtis' catalogue of indigenous and naturalized plants of North Carolina. Jour. Elisha. Mitch. Sci. Soc. **2:** 72–76.

IVES, S. A. 1944. The vascular plants of Greenville County, S. C. Bull. Furman Univ. **27:** 1–28.

JURICA, H. S. 1922. A morphological study of the Umbelliferae. Bot. Gaz. **70:** 292–307.

KEPHART, HORACE. 1931. Early spring flowers of the North Carolina mountains. Jour. Sou. Appal. Bot. Club **50:** 77–83.

KNUTH, PAUL. 1908. Handbook of Flower Pollination. Vol. II. The Clarendon Press, Oxford.

LEWIS, I. F. 1919. The vegetation of Shackleford Bank. N. C. Geol. Surv. Econ. Paper **46:** 1–40.

LOWE, E. N. 1921. Plants of Mississippi. Miss. St. Geol. Surv. Bull. **17:** 1–293.

MATHIAS, MILDRED, AND L. CONSTANCE. 1941. A synopsis of North American species of Eryngium. Amer. Mid. Nat. **25:** 365–387.

———— 1942. A synopsis of the American species of Cicuta. Madroño **6:** 145–151.

———— 1944–1945. Umbelliferae. North Amer. Flora **28B:** 43–295.

MCATEE, W. L. 1919. Notes of the flora of Church's Island, North Carolina. Jour. Elisha Mitch. Sci. Soc. **35:** 61–75.

MEMMINGER, E. R. 1915. A list of plants growing spontaneously in Henderson County, North Carolina. Jour. Elisha Mitch. Sci. Soc. **30:** 126–156.

MOHR, CHARLES. 1901. Plant Life of Alabama. Cont. U. S. Nat. Herb. **6:** 1–921.

OOSTING, H. J. 1942. An ecological analysis of the plant communities of Piedmont, North Carolina. Amer. Mid. Nat. **28:** 1–126.

PEATTIE, D. C. 1929. Flora of the Tryon region of North and South Carolina. IV. Jour. Elisha Mitch. Sci. Soc. **45:** 59–100.

QUARTERMAN, ELSIE, AND CATHERINE KEEVER. 1947. A summer check list of the Highlands region. Highlands Mus. and Biol. Lab. Pub. **6:** 1–39.

RADFORD, A. E. 1948. The vascular flora of the olivine deposits of North Carolina and Georgia. Jour. Elisha Mitch. Sci. Soc. **64:** 45–106.

REDFIELD, J. H. 1897. Notes of a botanical excursion into North Carolina. Bull. Torr. Bot. Club **6**: 331–339.

ROBINSON, B. L. 1919. An unusual *Daucus carota*. Rhodora **21**: 70–71.

RYDBERG, P. A. 1926. Botanizing in the higher Alleghany Mountains. Jour. N. Y. Bot. Gard. **27**: 80–88.

——— 1931. *Zizia Bebbii*. Addisonia **16**: 95–96.

SIFTON, H. B. 1925. Poison canals of *Cicuta maculata*. Bot. Gaz. **80**: 319–324.

SMALL, J. K. 1933. Manual of the Southeastern Flora. Pub. by the Author, New York.

——— and A. A. HELLER. 1893. Flora of western North Carolina and contiguous territory. Mem. Torr. Bot. Club **3**: 1–39.

SCHWEINITZ, L. D. 1836–1837. Plants of Europe naturalized in the United States. Ann. Lyc. Nat. Hist. **3**: 148–155.

WALTER, THOMAS. 1788. Flora Caroliniana. J. Wenman, London.

WANSCHER, J. H. 1934. Secondary (chromosome) associations in Umbelliferae and Bicornes. New Phytol. **33**: 58–65.

WELLS, B. W. 1928. Plant communities of the coastal plain of North Carolina and their successional relations. Ecology **9**: 230–242.

——— 1932. The Natural Gardens of North Carolina. Univ. of North Carolina Press, Chapel Hill.

WILLIS, J. C. 1948. A Dictionary of the Flowering Plants and Ferns. 6th ed. The University Press, Cambridge.

WOOD, THOMAS F., AND GERALD MCCARTHY. 1886. Wilmington Flora: A list of plants growing about Wilmington, North Carolina. Jour. Elisha Mitch. Sci. Soc. **3**: 77–141.

PLATE 13

Surface view and cross sections of fruits of the following species:

FIG. 1. *Hydrocotyle umbellata*
FIG. 2. *Centella erecta*
FIG. 3. *Eryngium yuccifolium*
FIG. 4. *Sanicula canadensis*
FIG. 5. *Daucus carota*
FIG. 6. *Torilis japonica*
FIG. 7. *Scandix pecten-veneris*
FIG. 8. *Osmorhiza longistylis*
FIG. 9. *Chaerophyllum tainturieri*
FIG. 10. *Cryptotaenia canadensis*
FIG. 11. *Coriandrum sativum*
FIG. 12. *Conium maculatum*
FIG. 13. *Erigenia bulbosa*
FIG. 14. *Foeniculum vulgare*
FIG. 15. *Petroselinum crispum*
FIG. 16. *Bupleurum rotundifolium*
FIG. 17. *Taenidia integerrima*
FIG. 18. *Thaspium barbinode*

PLATE 14

Surface view and cross sections of fruits of the following species:

FIG. 19. *Zizia aptera*
FIG. 20. *Carum carvi*
FIG. 21. *Ligusticum canadense*
FIG. 22. *Spermolepis divaricata*
FIG. 23. *Apium graveolens*
FIG. 24. *Ammi visnaga*
FIG. 25. *Sium suave*
FIG. 26. *Cicuta maculata*
FIG. 27. *Ptilimnium capillaceum*
FIG. 28. *Lilaeopsis chinensis*
FIG. 29. *Oxypolis rigidior*
FIG. 30. *Angelica venenosa*
FIG. 31. *Conioselinum chinense*
FIG. 32. *Heracleum lanatum*
FIG. 33. *Pastinaca sativa*

PLATE 13

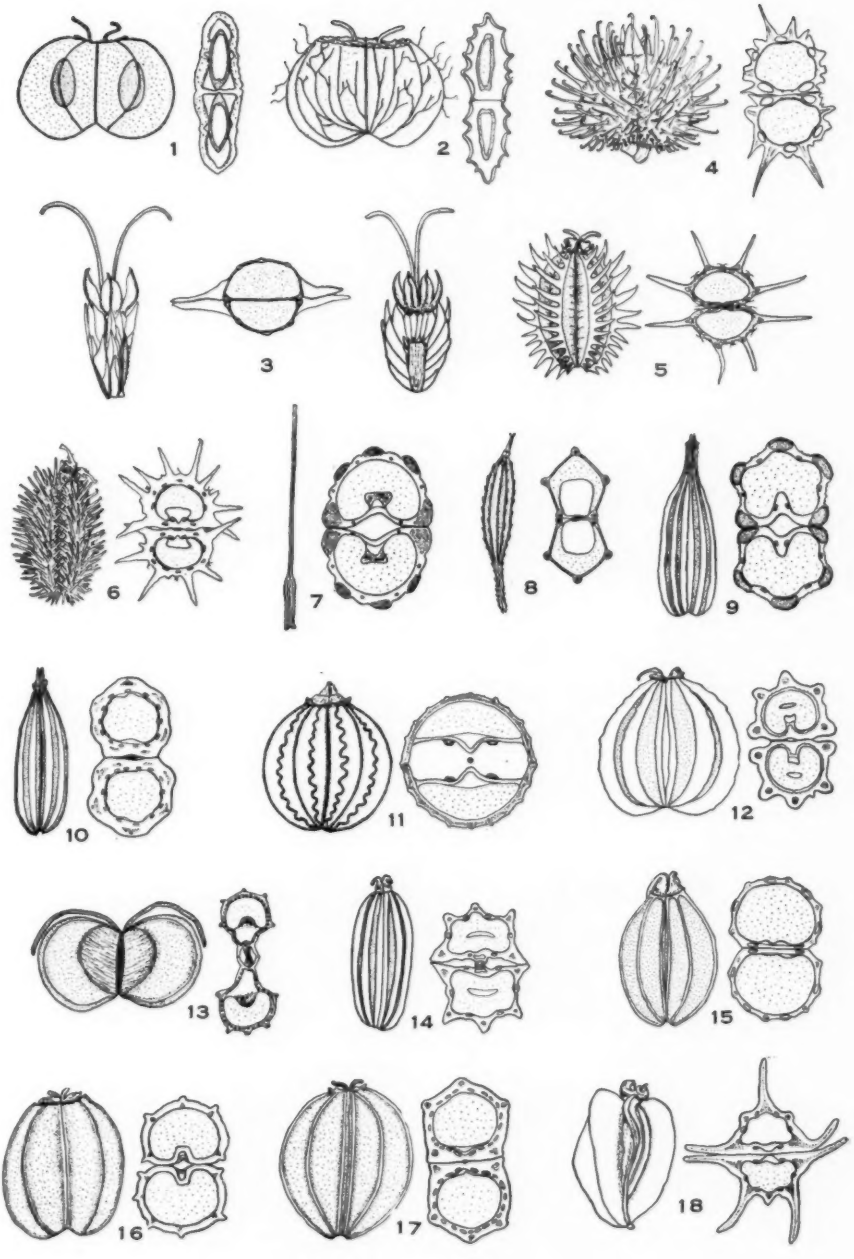


PLATE 14

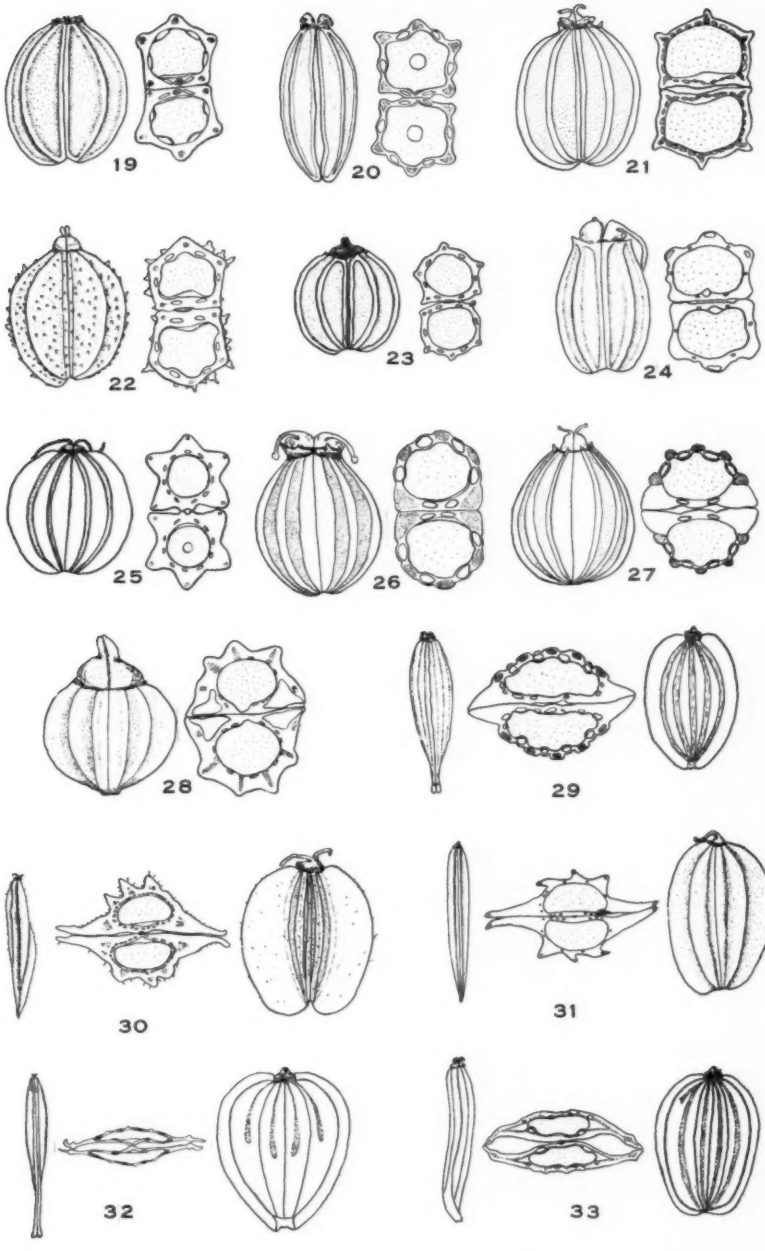


PLATE 15

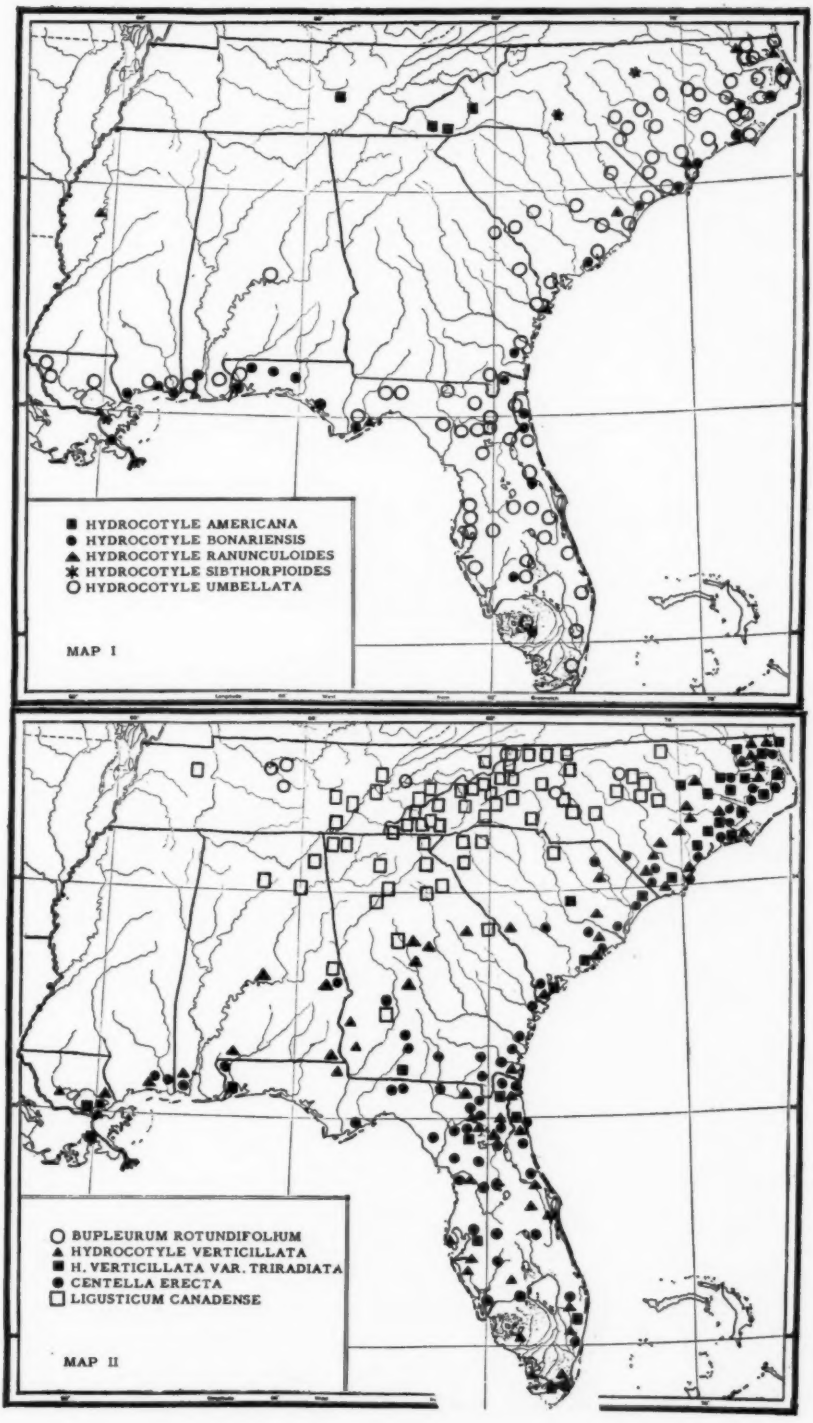
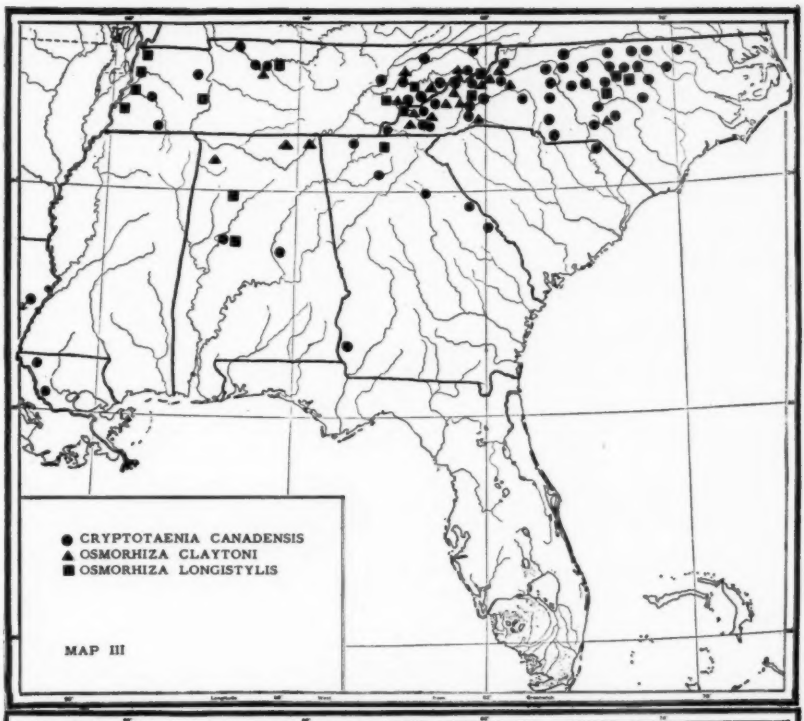

HYDROCOTYLE AMERICANA
HYDROCOTYLE BONARIENSIS
HYDROCOTYLE RANUNCULOIDES
HYDROCOTYLE SIBTHORPIOIDES
HYDROCOTYLE UMBELLATA
MAP I
BUPLEURUM ROTUNDIFOLIUM
HYDROCOTYLE VERTICILLATA
H. VERTICILLATA VAR. TRIRADIATA
CENTELLA ERECTA
LIGUSTICUM CANADENSE
MAP II

PLATE 16


● CRYPTOTAENIA CANADENSIS
▲ OSMORHIZA CLAYTONI
■ OSMORHIZA LONGISTYLIS
MAP III

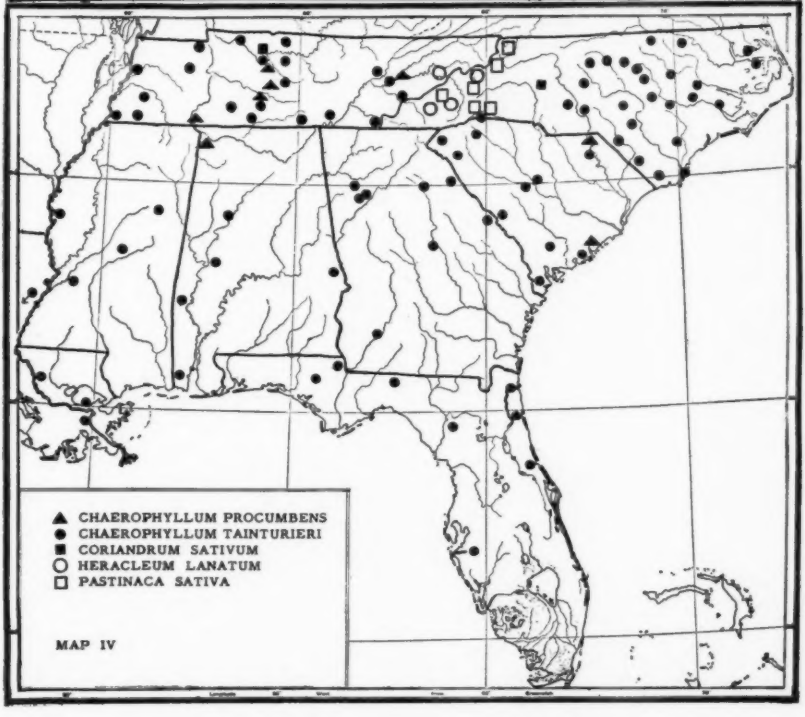
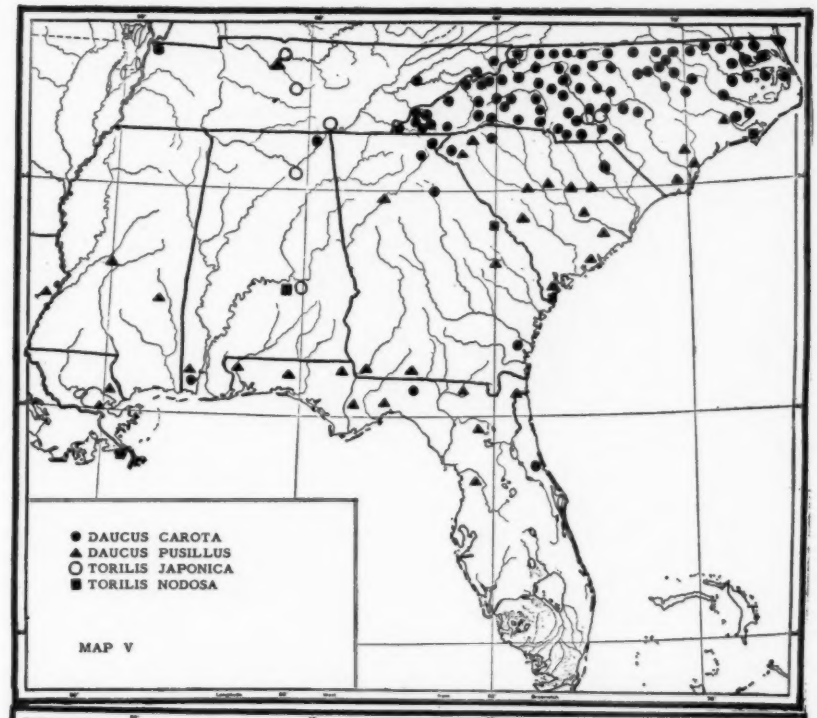

▲ CHAEROPHYLLUM PROCUMBENS
● CHAEROPHYLLUM TAINTURIERI
■ CORIANDRUM SATIVUM
○ HERACLEUM LANATUM
□ PASTINACA SATIVA
MAP IV

PLATE 17


DAUCUS CAROTA
DAUCUS PUSILLUS
TORILIS JAPONICA
TORILIS NODOSA
MAP V

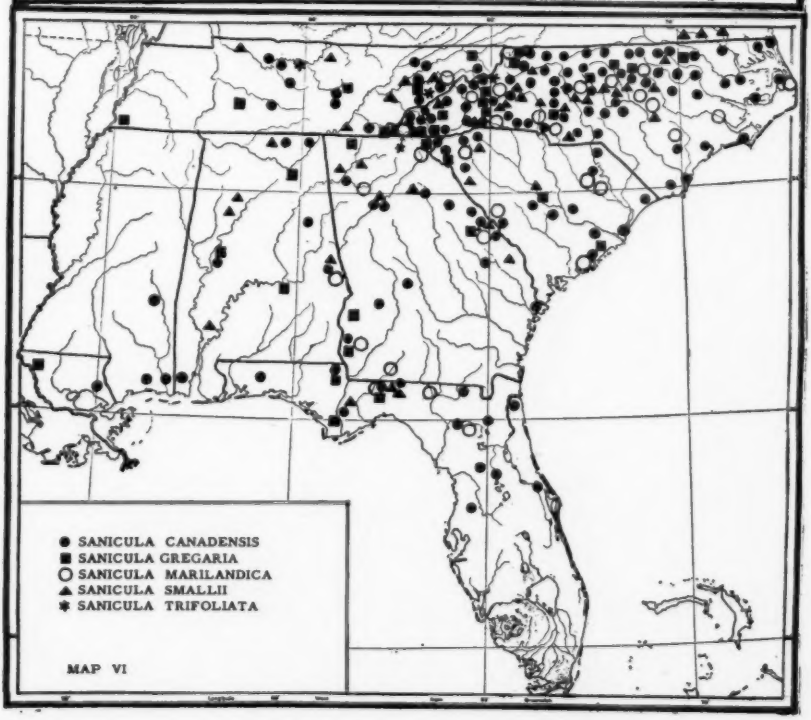
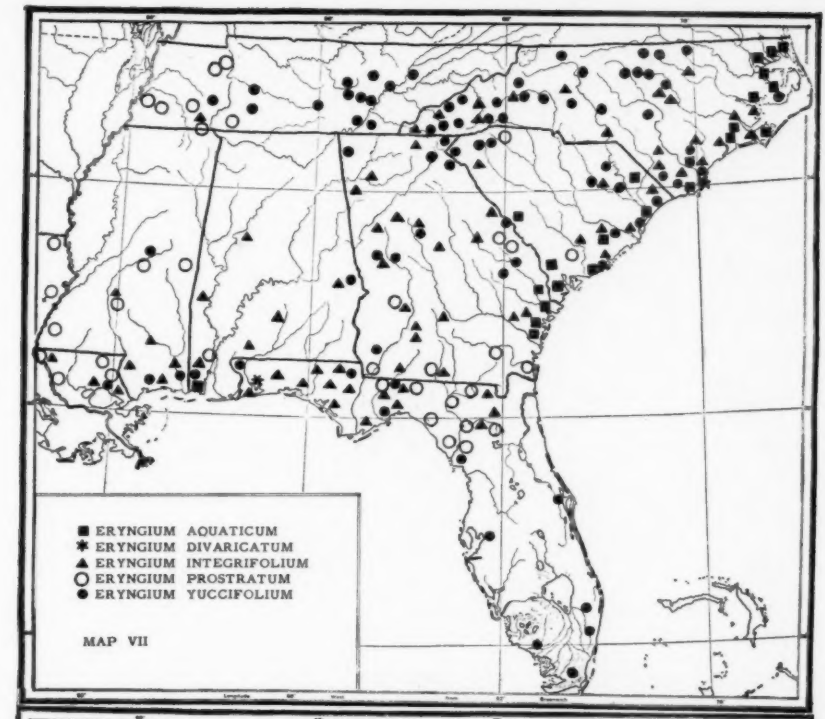

SANICULA CANADENSIS
SANICULA GREGARIA
SANICULA MARILANDICA
SANICULA SMALLII
SANICULA TRIFOLIATA
MAP VI

PLATE 18


ERYNGIUM AQUATICUM
ERYNGIUM DIVARICATUM
ERYNGIUM INTEGRIFOLIUM
ERYNGIUM PROSTRATUM
ERYNGIUM YUCCIFOLIUM
MAP VII

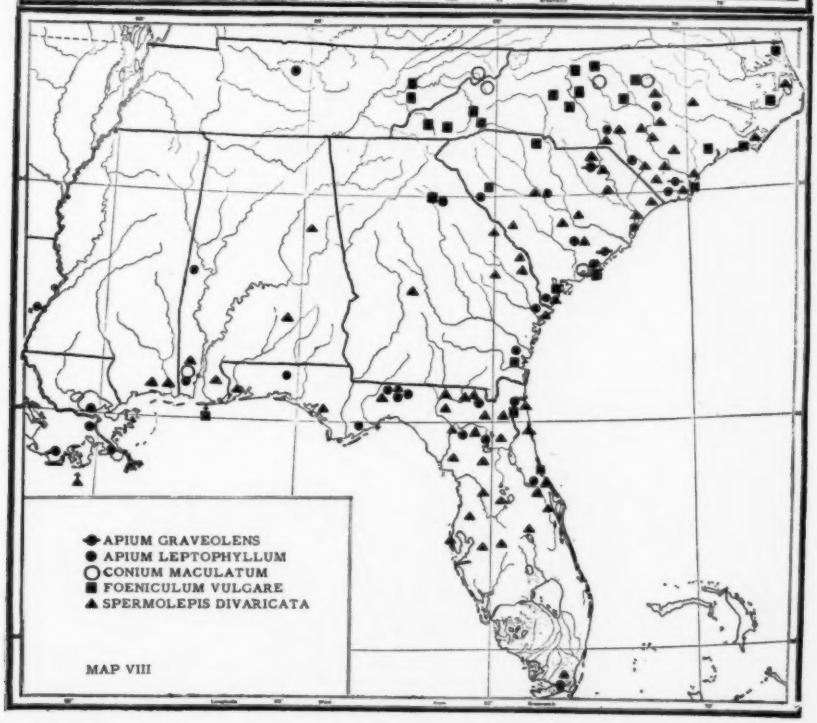
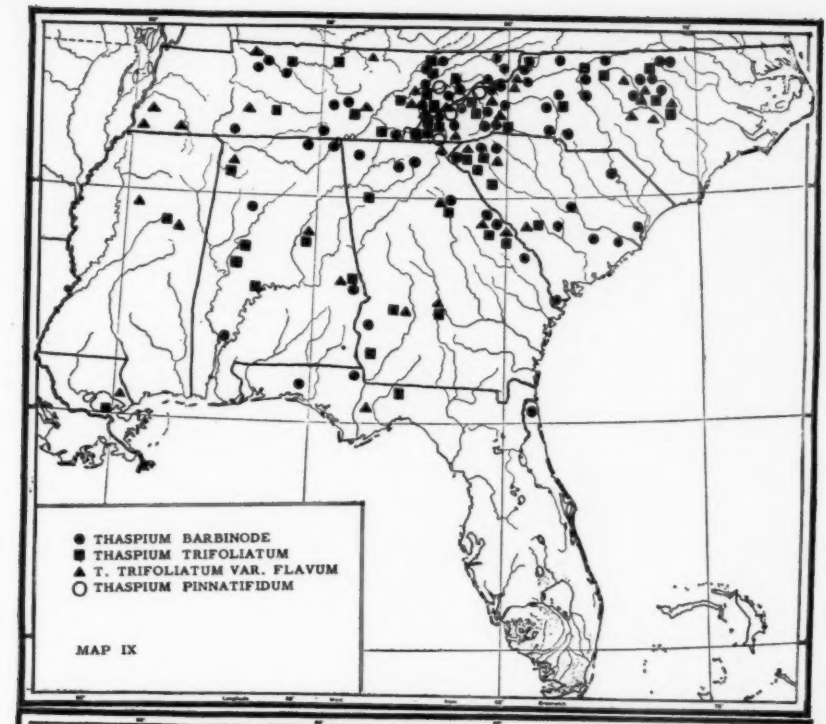

APIUM GRAVEOLENS
APIUM LEPTOPHYLLUM
CONIUM MACULATUM
FOENICULUM VULGARE
SPERMOLEPIS DIVARICATA
MAP VIII

PLATE 19


THASPIUM BARBINODE
THASPIUM TRIFOLIATUM
T. TRIFOLIATUM VAR. FLAVUM
THASPIUM PINNATIFIDUM
MAP IX

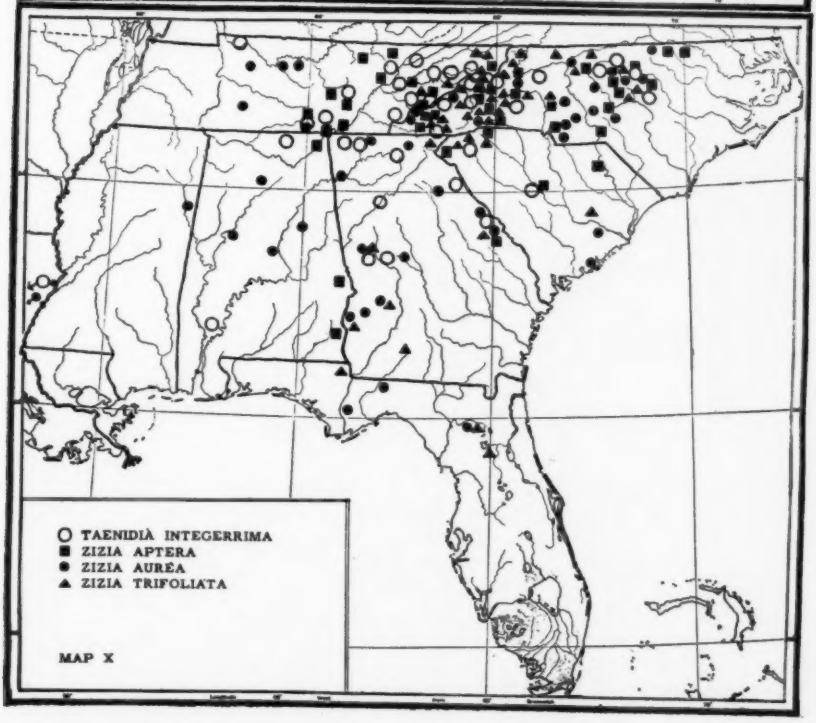
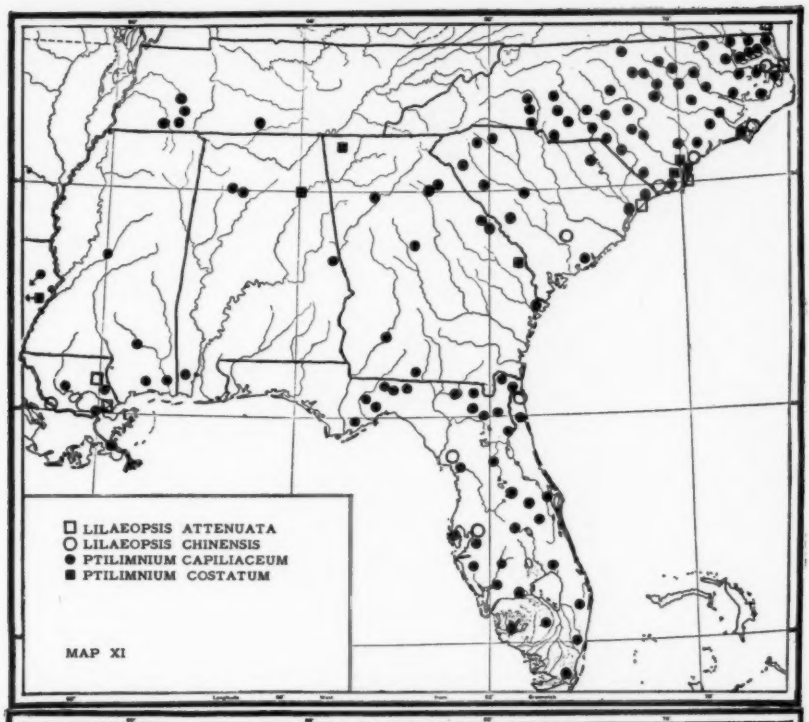

TAENIDIA INTEGERRIMA
ZIZIA APTERA
ZIZIA AUREA
ZIZIA TRIFOLIATA
MAP X

PLATE 20


LILAEOPSIS ATTENUATA
LILAEOPSIS CHINENSIS
PTILIMNIUM CAPILIACEUM
PTILIMNIUM COSTATUM
MAP XI

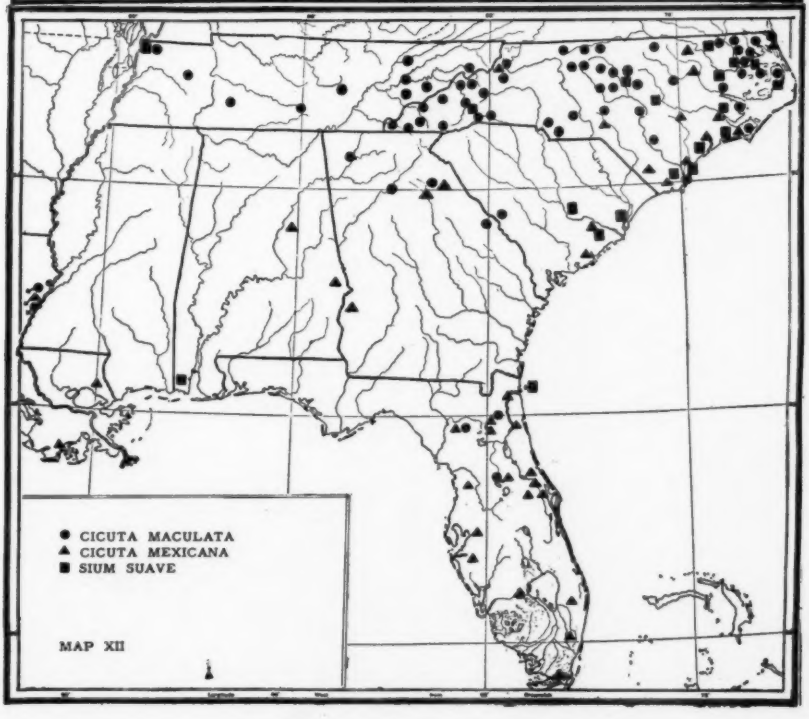
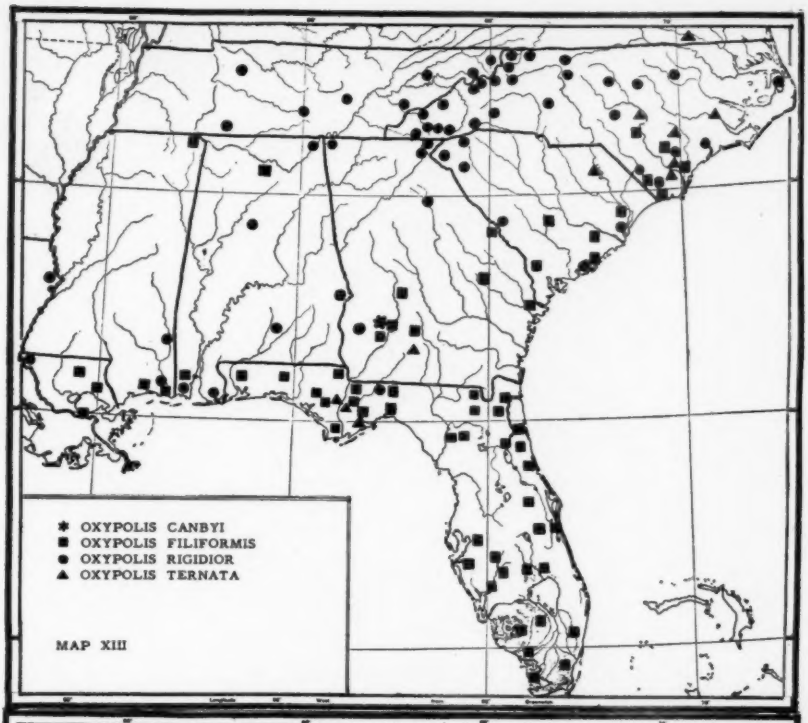
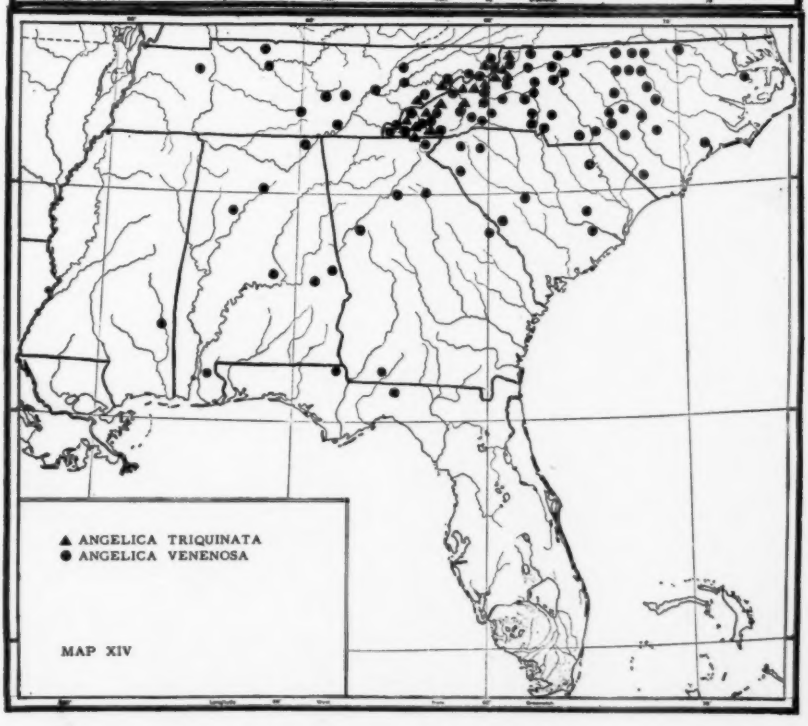

CICUTA MACULATA
CICUTA MEXICANA
SIUM SUAVE
MAP XII

PLATE 21


OXYPOLIS CANBYI
OXYPOLIS FILIFORMIS
OXYPOLIS RIGIDIOR
OXYPOLIS TERNATA
MAP XIII


ANGELICA TRIQUINATA
ANGELICA VENENOSA
MAP XIV

JOURNAL

OF THE

Elisha Mitchell Scientific Society

VOLUME 66
1950

This Society was founded in 1883 through the efforts of
Francis Preston Venable

Published for the Society
by the
University of North Carolina Press

CONTENTS OF VOLUME 66

THE EARLY DEVELOPMENT OF HAPLOSCOLOPLOS BUSTORIS (EISIG). *Edward C. Horn* and *C. G. Bookhout* 1

RECORDS AND DESCRIPTIONS OF DIPLOPODS FROM THE SOUTHERN APPALACHIANS. *Richard L. Hoffman* 11

STUDIES ON MYCOSPHAERELLA ROSIGENA. *D. E. Ellis* and *C. N. Clayton* .. 35

BOPYRID ISOPODS FROM THE COAST OF NORTH CAROLINA. *A. S. Pearse* 41

CAROLINA BAYS IN RELATION TO THE NORTH CAROLINA COASTAL PLAIN. *David G. Frey* 44

THE HISTORY OF THE DISCOVERY (1600–1680) OF THE SPIRAL VALVE IN THE LARGE INTESTINE OF ELASMOBRANCHS AND A GANOID. *E. W. Gudger* .. 53

STUDIES IN THE LEGUMINOSAE. V. CYTOLOGICAL OBSERVATIONS ON CROTALARIA. *Earlene Atchison* 70

THE EFFECT OF A VITAMIN A DEFICIENT DIET ON THE NATURAL AND ACQUIRED RESISTANCE OF MICE TO INFECTION WITH TRICHINELLA SPIRALIS. *John E. Larsh, Jr.* and *Hazel B. Gilchrist* 76

NOTES ON ISOETES IN NORTH CAROLINA. *A. E. Radford* 84

ACTINOPLANES, A NEW GENUS OF THE ACTINOMYCETALES. *J. N. Couch* 87

PROCEEDINGS OF THE FORTY-SEVENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE 93

PROCEEDINGS OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY 121

HERPETOLOGICAL NOTES FROM EASTERN NORTH CAROLINA. *William B. Robertson* and *Edwin L. Tyson* 130

A NEW SPECIES OF DIAPTOMID COPEPOD FROM MANITOBA. *I. Gilbert Arnason* 148

SOME ESTERS OF THE ISOMERIC NITRO- AMINOBENZENESULFONIC ACIDS. *R. W. Bost* and *George F. Deebel* 157

A STUDY OF THE CONDITIONS INVOLVED IN THE PREPARATION OF 3,5-DIIODO-4-OXO-1-PYRIDINE-ACETIC ACID (DIODRAST) CONTAINING IODINE-131. *Arthur Roe, R. L. Hayes,* and *H. D. Bruner* 163

THE ODORS OF MONO- AND DIARYLALKANES. *Walter H. Hartung* and *Henry Dale Smith* 171

A STUDY OF THE TRANSLOCATION OF RADIOACTIVE PHOSPHORUS IN LOBLOLLY PINE (*Pinus Taeda* L.). *Donald E. Moreland* 175

SOME PHYSIOLOGICAL ASPECTS OF FERTILITY IN *Achlya tuberculata*. *A. W. Ziegler* and *Betty Linthicum* 182

STUDIES IN THE COMPOSITAE OF NORTH CAROLINA. III. *R. K. Godfrey* 186

THE UMBELLIFERAE OF NORTH CAROLINA AND THEIR DISTRIBUTION IN THE SOUTHEAST. *Charles Leland Rodgers* 195

DEC 27 1950